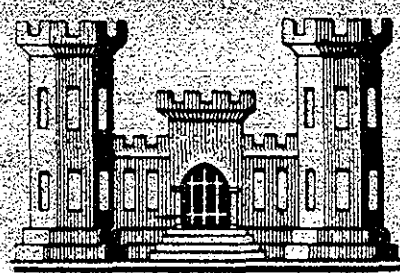
HURRICANE PROTECTECTION PROJECT

STRATFORD
HURRICANE BARRIER

LONG ISLAND SOUND AND HOUSATONIC RIVER,
CONNECTICUT

DESIGN MEMORANDUM NO. 3

CONCRETE MATERIALS



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

MARCH 1970

ENGCW-EZ (30 Oct 62) 3rd Ind
SUBJECT: Stamford Hurricane Barrier, Stamford, Connecticut
Design Memorandum No. 3 - General

Office, Chief of Engineers, Washington 25, D.C., 7 February 1963

TO: Division Engineer, U. S. Army Engineer Division, New England

Actions indicated in the 2d indorsement are satisfactory. Revised pages of subject design memorandum are approved.

FOR THE CHIEF OF ENGINEERS:

Incls w/d

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

Plats (2; Nos. 12) 2nd Ind
SUBJECT: Shoalest [illegible] harbor, Chesapeake, Hampton Roads
Section Reconnaissance No. 3 - Inshore

[illegible] Army Engr [illegible] Norfolk, Va., [illegible]. 7 Feb 1939 [illegible]

TO: Chief of [illegible], U. S. [illegible], Washington, D. C.

1. [illegible] navigation [illegible] and [illegible] navigation [illegible] memoranda.

2. The survey report [illegible] of the navigable [illegible] definite details of [illegible] the subject [illegible] accordingly [illegible]

[illegible]

12 Incls (10 cys)
1. Revised [illegible]
2. " "
3. " "
4-11. " " Nos. 3-10
12. Plate 3-B

[illegible]
Chief, Maintenance Division

cc: Mr. Leslie
Mr. Hill
Mr. Martin
Engr. Div. File

ENGCW-EZ (30 Oct 62) 1st Ind
SUBJECT: Stamford Hurricane Barrier, Stamford, Connecticut
Design Memorandum No. 3 - General

Office, Chief of Engineers, Washington 25, D. C., 17 December 1962

TO: Division Engineer, U. S. Army Engineer Division, New England

1. Reference is made to letter, NEDEW, 2 November 1962, subject: "Stamford Hurricane Barrier, Stamford, Connecticut - Design Memorandum No. 3 - Revised Pages."

2. Design Memorandum No. 3 and the revised pages referenced in paragraph 1 above, are approved subject to the following comments:

a. Paragraphs 27 through 30. In the preparation of Design Memorandum No. 7, Local Utilities and Pumping Stations, the following should be considered:

(1) The use of variable speed motors to drive one of the pumps in stations Nos. 3 and 4 is questioned.

(2) The number of pumps shown on Plate No. 3-23 for station No. 1 appears to be more than necessary for the capacity to be pumped. The cost of the station, therefore, is higher than it should be. Also, the entrance of water into the sump through two sluice gates, located at 90° to each other in one corner of the sump, is not considered good sump design. Such an arrangement may produce flow conditions which would adversely affect the operation of the pumps fartherest from the entrance. The inflow to the sump should be such that it enters the sump evenly through gates in the wall opposite the pumps at a velocity not exceeding 4 ft./sec.

b. Plates 3-7 and 3-8. Consideration should be given to protecting the panel wall with a wood bumper system anchored to the concrete piles in locations where ships are expected to dock.

c. Plate 3-24. It is suggested that the effect of possible silt accumulation on the navigation gate in its normal "down" position be investigated and that consideration be given to providing means of flushing off possible accumulation. The gate should be provided with latches at both ends to hold the gate in the raised "closed" position against reverse head caused by wave action.

d. The design memorandum proposes a reduction in the contribution to be made by local interests for maintenance of the navigation gate due to change in design of the gate and to a cooperative arrangement with local

[illegible] (for Col. O.)
[illegible] Reference Bureau, Stamford, Connecticut
[illegible] Section No. 3 - General

[illegible] maintenance of one of the three additional navigation [illegible] the design submission. The reasons given for reducing [illegible] maintenance cost should receive further review in connection [illegible] design of the gate and final determination of the lifting gear [illegible]. The survey report estimate for annual maintenance of the navigation gate should be retained until more definitive design is available.

c. In connection with estimating the contribution to be made for [illegible] maintenance of the navigation gate, it is noted that patching of the gate is projected to be accomplished once every 10 years. From this information, it appears that the calculation to reduce the estimated cost of periodic painting of the gate to annual cost has incorporated the wrong interest factor. It is assumed that the interest rate used is 2 7/8 percent, for which the sinking fund factor would be 0.0877. This would produce an annual cost of $4,830 instead of $4,000. The increase of $830 in annual cost makes a substantial difference in the contribution required on the basis of a 100-year life.

d. It is also noted that the calculation of local contribution for [illegible] maintenance of the navigation gate is based on a 50-year life although the project economics has been changed to a 100-year life. If it is expected that the Federal Government will maintain the gate for 100 years, the calculation should be based on a 100-year life. This involves the use of a present worth factor of 32.739 instead of a present worth factor of 26.351. This change would substantially increase the required local contribution. The [illegible] required replacement of equipment costs should be calculated on the same [illegible] basis as the total cost calculation.

e. Appropriate revisions of the design memorandum should be made and [illegible] should be submitted for approval.

FOR THE CHIEF OF ENGINEERS:

Incl
n/c

[illegible]
Chief, Engineering Division
Civil Works

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO.

NEDGW

30 October 1962

SUBJECT: Stamford Hurricane Barrier, Stamford, Connecticut
Design Memorandum No. 3 - General

TO: Chief of Engineers
ATTENTION: ENGCW-E
Department of the Army
Washington, D. C.

In accordance with EM 1110-2-1150 there are submitted herewith for review and approval 10 copies of Design Memorandum No. 3, General Design, Stamford Hurricane Barrier, Stamford, Connecticut.

FOR THE DIVISION ENGINEER:

JOHN WM. LESLIE
Chief, Engineering Division

Incl (10 cys)
Design Memo No. 3 -
General - Stamford

STAMFORD HURRICANE BARRIER

STAMFORD, CONNECTICUT

DESIGN MEMORANDUM NO. 3

GENERAL

Index to Design Memoranda

No.	Title	Submission Date	Approved
1	Site Geology	28 Sept 1962	
2	Concrete Materials		
3	General	30 Oct. 1962	
4	Hurricane Tidal Hydraulics	28 July 1962	6 Sept 1962
5	Foundations and Embankments		
6	Real Estate		
7	Local Utilities and Pumping Stations		
8	Navigation Gate		
9	Flood Walls		

STAMFORD HURRICANE BARRIER
STAMFORD, CONNECTICUT
DESIGN MEMORANDUM NO. 3
GENERAL DESIGN

CONTENTS

LIST OF PLATES

STAMFORD HURRICANE BARRIER

STAMFORD, CONNECTICUT

DESIGN MEMORANDUM NO. 3

GENERAL DESIGN

A. PERTINENT DATA

Purpose. -	Hurricane Flood Protection
Location of Structures. -	
State	Connecticut
County	Fairfield
City	Stamford
Harbor	Stamford, West Branch, East Branch.
Drainage Areas. -	Acres
West Branch	218
East Branch	1156
Westcott Cove	183
Total	1557
Embankments. -	
Type	Compacted earth fill with rock facing.
Elevation - Top of Embankment	East Branch, 17.0 m.s.l. West Branch, 17.0 m.s.l. Westcott Cove, 18.0 m.s.l.
Total length	11600 feet
Maximum height (East Branch)	29 feet (East Branch)
Side slopes	1 on 2, 1 on 1.5 Land Side 1 on 3, 1 on 1.5 Sound Side
Top width	10 feet, Land Sections 20 feet, Water Sections
Navigation Gate. -	
Type	Steel flap gate with concrete abutments.

Navigation Gate (Cont'd)

Number	1
Size	90 feet clear x 35 feet
Elevation of sill	-18.0 m.s.l.
Elevation of operating platform	+17 m.s.l.
Operating mechanism	Electric motor driven hoist

Walls. -

Anchored pile wall

Concrete panels and piles, tied back to concrete deadmen

Top elevation	17.0 m.s.l.
Length	1220 feet

1220.0
160.0
11600.0
13980.0

Cantilever reinforced concrete wall

Top elevation	17.0 m.s.l.
Maximum height	16 feet
Length	160 feet

Pumping Stations. -

Structure	Reinforced concrete
Pumps	Vertical axial flow
Power units	Electric motors

Pumping Capacity

Station	Capacity - c.f.s.
No. 1	510
No. 2	100
No. 3	50
No. 4	140

5 Pumps
3 Pumps

229,500
45,000
22,500
63,000
360,000

Principal Quantities, C. Y. -

Excavation, land	42,000
Excavation, water	110,000
Excavation, rock	4,400
Impervious fill	120,000
Pervious fill	55,000
Random fill	23,000

Principal Quantities, C. Y. (Cont'd)

Rock Fill	23,000
Armor stone	26,000
Bedding stone	3,000
Gravel	28,000
Rock filter	3,000
Topsoil	4,000
Concrete pile wall	1,320 l.f.
Concrete, reinforced (except pumping station)	2,015
Concrete, mass	5,370

Structural Steel Navigation Gate - 553,000 lbs.

Estimated Project Costs. -

Lands and Damages		$ 500,000
Construction Costs		
Dike ramps, Earth work	$1,413,000	
Walls	661,500	
Navigation Gate	1,054,000	
Pumping Stations	1,011,000	
Utilities	339,000	
Sub-total	$4,478,500	
Contingencies 15%	671,500	5,150,000
Engineering and Design		437,000
Supervision and Administration		445,000
Preauthorization Studies		50,000
Total Project Cost		$6,582,000
Federal Funding		3,742,000
Non-Federal Contribution		2,840,000
Non-Project Cost		270,000

B. PROJECT AUTHORIZATION

1. Authorization. - The hurricane-flood protection plan for the City of Stamford, Connecticut, was authorized by the Flood Control Act dated 14 July 1960 (Public Law 86-645, 86th Congress) which reads in part as follows:

"STAMFORD, CONNECTICUT

The project for hurricane-flood protection at Stamford, Connecticut, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 210, Eighty-sixth Congress, 1st Session, at an estimated Federal Cost of $3,030,000 for construction and at an estimated Federal Cost of maintenance and operation of $31,000 annually."

2. Requirements of Local Cooperation. - The requirements of local cooperation as contained in House Document No. 210 read as follows: ". . . provided that, prior to initiation of construction, local interests give assurances satisfactory to the Secretary of the Army that they will: (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project; (b) accomplish without cost to the United States all modifications to the existing storm drainage system which may be required to obtain the full benefits of the protection plan, all necessary modifications to the existing sanitary sewer facilities required to prevent the entry of tidal-flood waters, and all changes, alterations, and additions to or relocations of any buildings and utilities made necessary by the construction of the project; (c) bear 30 percent of the total first cost, a sum presently estimated at $1,676,000 to consist of the items listed in (a) and (b) above and a cash contribution now estimated at $1,406,000, the cash to be paid in a lump sum prior to commencement of construction and the final apportionment of cost to be made after actual costs and values have been determined; (d) contribute in cash, in lieu of the cost of annual maintenance and operation of the tidal portion of the East Branch barrier, an amount presently estimated at $880,000, the cash to be paid in a lump sum prior to commencement of construction; (e) maintain and operate all the works after completion, with the exception of the tidal portion of the East Branch barrier and aids to navigation, in accordance with regulations prescribed by the Secretary of the Army; and (f) hold and save the United States free from damages due to the construction works and the operation thereof."

3. Status of Project. - There is no prior project for protection against tidal flooding.

The project is under design.

C. INVESTIGATIONS

4. Hurricane Flood Report. - Hurricane tide flooding was reported in the Interim Report on Hurricane Survey, Stamford, Connecticut, (House Document No. 210, 86th Congress, 1st Session, 1959. In the preparation of this report studies by Architect Engineer firms engaged by the City were initially reviewed, alternate alignments were considered and the most favorable alternate selected. Surveys and explorations were made for the selected alignment, and a definite plan for protection was developed. There have been no subsequent investigations of tidal flooding.

5. Investigations for Navigation and Beach Erosion Control. - There have been several published reports on navigation in Stamford Harbor and Westcott Cove and on beach erosion control, as listed below:

a. Navigation - Stamford Harbor.

(1) House Document No. 1130, 63rd Congress, 2nd Session, 1914
(2) River and Harbor Document No. 8, 74th Congress, 1st Session, 1934.
(3) River and Harbor Document No. 29, 75th Congress, 1st Session, 1937.
(4) River and Harbor Document No. 676, 79th Congress, 2nd Session.

b. Navigation - Westcott Cove: River and Harbor Document No. 379, 80th Congress, 1st Session, 1947.

c. Beach Erosion Control: House Document No. 174, 85th Congress, 1st Session.

D. LOCAL COOPERATION

6. Compliance with Requirements of Local Cooperation. - Informal assurances of local cooperation have been furnished by the City of Stamford and also by the State of Connecticut, which will share one-half each of the cost of local cooperation.

The City of Stamford has placed in escrow the sum of $650,000 towards its share of the cost and expects to have the remainder available by the time of initiation of construction.

The State of Connecticut has authorized the issuance of bonds in the amount of $1,278,000, the estimated maximum State's participation in local interests costs at the time.

7. Concurrence in Plans. - Conferences have been held with the City of Stamford on all developments of the project, and they have expressed informal approval of the plans. In compliance with the request of the Water Resources Commission the State of Connecticut has been kept informed of the progress of planning.

8. Estimated Cost of Local Cooperation. - The estimated cost of local cooperation is as follows:

Lands, easements, and rights-of-way		$ 500,000
Modifications of storm drainage system and other utilities		132,000
Cash contribution 30% of first cost less above		1,328,000
Cash contribution in lieu of the cost of annual maintenance and operation of the navigation gate		880,000
	Total	$2,840,000
Replacement of storm drain from Crosby St. and Pacific St. for local interests		$ 270,000

E. PROJECT PLAN

9. Location. - The project is located in the City of Stamford, Connecticut. The protection works extend along the east bank of the West Branch from the mouth of the Rippowam River, across East Branch, and along Westcott Cove to high ground to the east.

The area protected amounts to approximately 600 acres at design stillwater level (el. 14.8 m.s.l.). In the area are located some of the principal manufacturing plants of the City, including a generating station of the Hartford Electric Light Co., as well as a portion of the main commercial district and residential sections.

10. General Description. - The plan of protection consists of a dike 4500 feet long on the east bank of the West Branch from the mouth of the Rippowam River to Dyke Park, a 2840 foot long dike with a 90-foot gated opening across the East Branch, and a dike 4250 feet long in the Westcott Cove area. The top elevation of the protective works is 17.0 m.s.l. in the East Branch and West Branch and 18.0 m.s.l. in the Westcott Cove area.

F. DEPARTURES FROM PROJECT DOCUMENT PLAN

11. Departures from Project Document Plan.

a. Interim Report Plan. - The departures from the project document plan include the following:

(1) Design stillwater level changed from el. 16.0 m.s.l. to 14.8 m.s.l., with corresponding change in top elevation of dikes.

(2) Elimination of gated passages through dikes and substitution of ramps.

(3) Provision of a 90-foot flap type navigation gate instead of a 75 foot sector gate.

(4) Provision of four storm water pumping stations, an increase of 3.

(5) Modification of the alignment to include a residential area at Mitchell Street.

(6) Modification of the alignment in the vicinity of the Hartford Electric Light Company.

(7) Addition of Pacific Street storm drain reconstruction at the request of the City.

The departures are described and explained under the appropriate paragraphs of this design memorandum.

b. Recommendations of the Chief of Engineers. - Letter from the Chief of Engineers, dated 10 April 1959, subject: Comments on Planning, Interim Report on Hurricane Survey, Stamford, Connecticut, reads in part as follows:

"2. The following comments on planning and design are forwarded for consideration during the preparation of the design memorandom after project authorization and the allotment of funds:

(a.) In the design of the interior drainage facilities, consideration should be given to the rainfall volume that would occur during the design hurricane. The increased volume in the ponding area resulting from precipitation should be considered in the final design stage of the project.

(b.) Plate E-4. In view of the short time that the design flood will be against the protective works, the need for the cutoff through the dredged fill just north of Rippowam Road is not apparent.

(c.) Plate E-6. Shorter gates with a flatter mitering angle should be considered.

(d.) Plate E-6. The 75 foot gate width appears to be a bare minimum. For a structure so difficult to alter, careful consideration should be given to future commercial and recreational traffic to determine whether or not the structure will become a serious hazard. On the basis of information presented in the report, a width of 100 feet would seem more proper.

(e.) Plate E-6. Sills should be provided for stoplogs.

(f.) Diesel engines should be used for driving the pumps instead of electric motors.

(g.) Plate E-7. Consideration should be given to enclosing the pump station foundation with steel sheet piling to prevent possible loss of soil from under the station by seepage."

The comments are considered in pertinent paragraphs of this design memorandum.

G. DETAILS OF PROJECT PLAN

12. East Branch Barrier.

a. Description. - The East Branch Barrier includes 2840 feet of rock-faced earth dike, a 90-foot navigation gate, and a pumping station which will be located in the navigation gate structure.

b. Departures from Interim Report. - The alignment is essentially that shown in the Interim Report. Access is from Dyke Park rather than through the narrow lanes of privately-owned Woodland Cemetery. The alignment at the east end has been changed because of recent housing construction on Wallace Street and to provide protection for a low area on Mitchell Street. Protection for the Mitchell Street dike extension is $93,000, an increase of $29,000 over that of the basic alignment at Wallace Street. The annual cost is estimated at $1200 and annual benefits at $6,200, with a benefit/cost ratio of 5.1:1. In view of the favorable benefit cost ratio the area has been included in the project.

13. West Branch Barrier.

a. General Description. - The West Branch Barrier includes 1340 feet of anchored concrete piling wall, 160 feet of cantilever concrete wall, and 1950 feet of rock-faced earth dike.

Flow of cooling water for the Hartford Electric Light Co. will pass through the barrier in gated intake and discharge conduits. In time of flood tides, intake flow will be controlled at the gated intake and discharge flow will be pumped through the dike by a pumping station. Small regulating pools will be provided.

One pumping station will provide for storm runoff and discharge of cooling water during periods of gate closure.

b. Station 0+00 to Station 12+20

(1) Interim Report Alignment. - The alignment presented in the Interim Report was located inboard of the existing dock and walls of the Hartford Electric Light Company plant and continued to the north along Atlantic Street in the rear of two retail oil companies. Comparison of alternate alignments and additional information on existing installations has indicated that the Report alignment is relatively unfavorable.

The area is crossed by many utility lines in Atlantic Street and in the plant yard. That portion in front of the plant is an essential access and work area to the plant. Wall footings would have to be deep as the existing steel sheet pile wall is badly corroded. They would be in close proximity to the plant footings so construction would involve some risk of damage to the plant.

The Interim Report plan contemplated that the older section of the plant generating facilities would be shut down during flood tides. This portion comprises 24,000 KW of the total capacity of 64,000 KW. This is unsatisfactory as maintenance in service of all available generating facilities is particularly important during a flood emergency. The existing cooling water intake and discharge of the older section are not designed for operation against flood tide heads and cannot be suitably modified without inconvenience and heavy expense.

The estimated cost of construction on this alignment is as follows:

Reinforced concrete cantilever wall, including 7 gated openings, 1300 lin. ft.	$ 433,600

Modification of plant intake structure		$ 10,000
Cooling water discharge gate structure		55,000
H. E. L. Co. yard piping modifications		10,000
Prestressed concrete pile wall at coal unloading dock, 200 lin. ft.		78,600
		$ 587,200
	Contingencies 15%	86,800
		$ 674,000
	Eng. & Overhead	113,000
		$ 787,000
	Rights-of-way and acquisition of existing bldgs.	115,000
	Total	$ 902,000

See Plates Nos. 3-25 and 3-26 for details.

(2) Adopted Alternate Alignment. - The adopted alternate alignment which is discussed in the following paragraphs, does not interfere with or handicap the present or future industrial activities of the area, as it is essentially on the West Branch bank line. It is an anchored concrete pile wall, with provisions for maintaining the Hartford Electric Co. plant in full operation during flood tides. The estimated cost is $904,000. The change in alignment is justified by the lessened interference with plant operations and by the fact that contingency of damage to existing structures is reduced and construction is less difficult.

(3) Pile Walls.

(a) Reason for Selection. - Several alternate types of construction for the barrier in this area were considered, including earth dike, concrete wall, steel sheet pile cellular wall, anchored steel sheet piling, and anchored concrete piling.

Earth dike construction is not possible because of lack of space. Reinforced concrete or mass concrete walls are too costly because of the depth of water and overburden above satisfactory foundations.

An anchored pile wall is best adapted to the site. Located at the waters edge it would leave the land areas unencumbered

with structures, while the unloading of oil and coal to dock facilities would not be handicapped. The sand and gravel foundation materials are generally favorable for driving piles. No cofferdam would be required, except for gate structures.

The wall will be constructed in brackish tidal waters. Alternate freezing and thawing will occur throughout the winter months. This combination of conditions is most severe in producing deterioration of concrete and corrosion of steel. The critical zone of attack corresponds to the tide range, plus one or two feet above and below.

A steel sheet piling wall is practical for the location, but the useful life of unprotected steel is unpredictable, with a maximum of about 35 years in the tidal zone. The existing steel sheet pile wall at the Hartford Electric Light Company, installed in 1930, has deteriorated to the point of complete failure. If a steel sheet pile wall were to be provided, protective measures would be essential. The best protection for steel in this zone would be concrete facing. Cathodic protection is ineffective above low tide. Protective paint must be renewed at intervals of 5 to 10 years. Concrete facing is suggested by a steel manufacturer and is considered satisfactory by the U. S. Bureau of Yards and Docks for protection of the steel. Concrete facing would also solve the problem of making watertight the interlocks of steel sheet piles against hurricane flood waters.

A concrete pile wall would be relatively long lived compared with steel sheet piling. Prestressed concrete should be more durable than ordinary reinforced concrete in tidal waters due to dense mix and to the section being all in compression. Panel construction is selected because of relative economy. Costs are comparable with a steel pile wall.

Relative costs of steel sheet piling and prestressed concrete construction have been estimated based on supplier's quotations and reviewed against bid prices, including prestressed concrete pile construction now under way at a Coast Guard dock in Boston, Massachusetts. Figures for a ten-ft. section are as follows:

(a) Prestressed concrete panel wall

Wall

H-Pile, 18" x 36" in place	57' @	$18.00	$1026
Prestressed conc. panels	10'x31' @	4.00	1240
Reinforced conc. panel	6 cy @	60.00	360

Deadman

H-Pile, 18" x 36" in place	20' @ $18.00	$ 360
Prestressed conc. panels 10' x31' @	4.00	600

Tie

Upper Rod	60' @ $ .57	$ 34.00	
Installation		75.00	
Lower Rod	60' @ 1.25	75.00	
Installation		200.00	
		$384.00	384

Exc. & Fill (not included, small in amount)	Sub-total	$ 3970
Contingencies, 15%		600
Total Cost		$ 4570

(b) Prestressed Pile Wall

Wall

Piles, 18" x 36" in place	57'x10' @ $6.00 sq.ft.	$ 3420
Walers 18" x 36" prestressed beam	2 x10' @ 18.00	360
Deadman, 12' x 2' continuous concrete section	8.8 cy.@ 60.00	528
Exc. and fill for deadman		120
Tie rods, as above		384
		$ 4812
Contingencies, 15%		728
Total Cost		$ 5540

(c) Steel Sheet Pile Wall

Piles, Z-38 (alloy steel)	10'x57' @ $5.00	$ 2850
Walers-top, 2-8][	11.5x10' @ .25	58
-bott.2-18][	58x10' @ .35	406
Deadman, as above		528

Exc. & Fill for deadman, as above	$ 120
Tie rods, as above	384
Concrete facing, 8"min., above el. -6 23' x 10' @ $4.00/sq.ft.	920
	$ 5266
Contingencies 15%	784
Total	$ 6050

(b) Description. - The concrete pile wall will consist of H-section soldier piles and intermediate panels. The soldier piles will be tied back to a deadman of generally the same type of construction. The overburden is too shallow to provide adequate lateral support, either for a continuous pile wall or for a panel wall. Therefore both top and bottom ties are necessary. Precast panels will be used in and below the tidal range or ground water level and prestressed concrete will be used where there is exposure to harbor water. The top panel, which will be above water level, will be cast-in-place reinforced concrete to close the points at the piles and to help maintain the piles in position. Joints between the precast panels and the piles will be grouted.

Granular fill will be used behind the wall.

(4) Hartford Electric Light Co. Cooling Water Flow. - Maintenance in service of full plant capacity during a storm emergency is advantageous and well-nigh essential, both for the welfare of the local community and also for standby capacity in case of interruptions in service elsewhere in the utility system. The plans of the barrier include provisions for uninterrupted service by maintenance of cooling water flow during flood tides.

(5) Cooling Water Intake. - A double-wall bulkhead will be constructed in front of the present intakes. It will form a storage pool of about 800,000 gallons capacity between the barrier wall and the existing harbor wall. The drawdown will be limited to el.-6.0, the experienced extreme low tide, to insure no increase of loading on the existing pile wall over that experienced in the past and to contribute to the stability of the double wall bulkhead. Two 5'-6" dia. gated intake conduits will be provided through the bulkhead. The gate will be controlled during flood tides from a station on the power plant switchboard, power will be obtained from the plant.

(6) Cooling Water Discharge. - An 8-foot diameter gated pipe will conduct cooling water discharge through the pile wall under normal conditions. On the occurrence of damaging tide levels, the discharge gate will be closed and flow diverted to Pumping Station No. 1.

A separate pumping station in the vicinity of the discharge was also considered. The most probable location of cooling water intakes for a future plant would be in this vicinity. Because of the higher temperature of the discharge flow, relocation of the existing discharge outlet could be expected. This could result in abandonment of pumping facilities and loss of the investment. The cost of a conduit to Dyke Lane outside the area available for future development and of increase in pumping installation at Pumping Station No. 1 would be equivalent to that of a separate pumping plant at the present discharge. Therefore, the recommended installation provides a pumping station at Dyke Lane for combined storm water and cooling water flows.

(7) Coal Dock Area. - The selected alignment is on the land side of the dock practically on the line of an existing 7-foot fence. This alignment was chosen after consultation with the owner so that it will present no consequential interference with discharge flow or coal handling operations. A panel wall will be provided because it will be independent of any necessity for maintenance or replacement of the existing sheet pile wall under the dock. Foundation explorations in the area of the dock show a deposit of cobbly gravel. Since the wall elevation in the tidal range will be below the surface and behind the existing pile wall, steel H-sections would be relatively free from corrosion. Steel H-sections will be used as the lower end of the piles because of the subsurface conditions.

A ramp will be provided for access of maintenance vehicles to the dock.

A reinforced concrete cantilever wall will be provided from approximately Station 12+85 to Station 14+85. This type of section becomes economical where construction can be conducted with little appreciable sheeting and pumping. It is used in front of the coal pile to the point where space is available for an earth dike.

(c) Station 12+20 to Station 32+50

(1) Description of Dike. - A rock-faced earth dike will be provided from the vicinity of the coal unloading dock of the

Hartford Electric Light Company to Dyke Park. An access ramp will be provided to the Luders Shipyard area.

(2) Relationship to Hartford Electric Light Company. - The alignment must cross property of the Hartford Electric Light Co. for a length of about 1,600 feet which is presently partially developed and incompletely occupied by scattered oil and gas tanks. The land is valued chiefly for future plant development. The present property lines do not necessarily indicate the area which may ultimately be held by the Hartford Electric Light Co. As a general statement, the entire vicinity is recognized as strategic for harbor front industrial development. In 1952 the predecessor owner had a scheme for future development prepared when studying where to locate a new plant to meet increased demand. This scheme is shown on Plate 3-27. There is no present plan to construct a plant here. Development would depend on increase in demand, relative economy in comparison with other sites, and full study of comparable alternate schemes for a plant at the site.

A dike alignment around the property which would be least detrimental to a future plant development as now foreseen is that shown in the Interim Report and is designated as the "Outboard Alignment" on Plates 3-9 and 3-27. A dike constructed on this alignment would have to be modified according to the scheme developed.

As shown on Plate 3-27 it would require dike modifications chiefly for cooling water intakes and discharge. This dike alignment is strongly urged by the Hartford Electric Light Co.

Construction of the outboard alignment would require removal of several feet of organic silt and also some sunken barges in two coves, where the dike would be about 21 feet high. It would also require the removal of a small dike currently under construction by the owner across the southwest cove and the removal of such fly ash as is placed against it by the owner prior to construction of the hurricane barrier. The estimated cost of the Outboard Alignment between Stations 20+50 and 32+50 is $251,000, a cost which will increase slightly as the owner's operations continue.

The most economical alignment and one which would present only a minor inconvenience to current plant operations lies inboard of the two coves and requires a dike uniformly about 8 feet high. The estimated cost is $117,000. It is the alternate included in the plans submitted herewith for approval.

In the event of future plant expansion, the area outside of the dike of approximately 3 acres would be available if the dike were moved to the vicinity of the outboard alignment, an item of some expense. The owner objects to the inboard alignment on the basis of severance of the acreage left outside the dike. Value of severance damage would logically be limited to cost of moving the dike. The cost of moving the dike would depend on conditions at the time, but would be in the general amount of the savings in cost for the inboard alignment.

As stated in Paragraph 40, without the advantage of a specific study, benefits from protection appear to outweigh any damages from loss of right-of-way, severance, or increased costs of operation. It might be concluded that such considerations should not influence overall comparative costs of alignments. A firm statement to this effect would be premature at this time.

From a standpoint of relative costs of construction only, construction on the outboard alignment would involve an additional estimated cost of $134,000, expended to protect a problematical future plant, and subject to such alterations as that future plant would necessitate. The additional cost is not considered justified. On this basis the inboard alignment has been selected for presentation and approval.

(d) Station 32+50 to Station 42+50. - The dike will continue across Dyke Park to the East Branch, serving as an access road. This section will be cut-and-fill, with the fill sections closing low saddles between the knolls. The slopes will be flattened and topsoiled and seeded, blending with the present and future development of Dyke Park.

Dyke Lane will be raised 3 feet to ramp over the dike.

14. Westcott Cove Barrier. -

(a) Description of Dike. - This section of barrier will protect the residential area of Rippowam Street and will skirt Westcott Cove in Cummings Park. It will be a rock-faced earth dike. Two small pumping stations will be provided. The top of dike is at El. 18.0, providing 1 ft. additional freeboard to reduce overtopping at design flood because of the small capacity of the pumping stations.

(b) Effect on Cummings Park. - Cummings Park is a highly developed and well-maintained waterside park. Inshore are scattered

STAMFORD BARRIER, CONNECTICUT

Q. State vs. City Share?

A. Special Act 328 of the 1961 Conn. Legislature authorizes issuance of bonds in the amount of $1,278,000 to provide State participation up to 50% in local costs. However, the State ruled at Pawcatuck that it would not participate in lands ($500,000) and relocations ($132,000). Secondly, the question of state participation in the contribution in lieu of O&M ($880,000) is still open. Discussions are still going on between Stamford and State Officials on these points.

Q. Assurances - Mayor?

A. We'll ask for formal assurances prior to construction and after Stamford and State settle their business.

baseball diamonds, tennis courts, and playgrounds. On the shore front there are two bathing beaches and a marina. The main access is from Shippan Avenue, skirting Westcott Cove and continuing to the East Beach. Principal access to the West Beach is by way of the streets of the Rippowam Street residential area.

The barrier dike will be located close to the shore of Westcott Cove with little effect on the playground area of the Park. It will be widened to ramp the main Park Drive over the dike. Parking areas will be provided in lieu of those rendered useless by construction of the dike. The substitute parking area for the West Beach will be on undeveloped City-owned land in rear of the dike, with a pedestrian ramp over the dike. This will have the incidental benefit of eliminating beach traffic from the residential area.

15. Street Ramps. - Ramps over the dikes will be provided where necessary for accommodation of traffic. The provision of ramps in lieu of gated barriers is feasible because locations are in relatively undeveloped areas and traffic is almost entirely to recreational areas.

Ramps are more economical to construct and maintain than gated or stop-logged closures. They eliminate the time consuming work of closure in the event of storm warning. Grades over the ramps will be a maximum of 8% and appropriate street signs will be installed for regulation of traffic.

The City of Stamford has informally expressed preference for ramps instead of gated closures.

H. NAVIGATION GATE

16. Navigation.

a. Navigation in East Branch. - There has been little change in commerce in Stamford Harbor since the date of the statistics quoted in the Interim Report (1956). In the latest reported year, 1959, total tonnage was 819,872 short tons, of which 154,200 was in the East Branch, where the navigation gate will be located. Of the tonnage in the East Branch, 120,000 was sand and gravel and 34,200 was iron and steel scrap. The present tendency is to develop the area for industry which would be relying on land transportation. No significant increase in tonnage is expected.

There were 265 vessel trips in the East Branch in 1959. The types of vessels in use consist of scows, barges and tugs with a greatest beam of 48 feet. Except for 2 or three trips a year, however, barges in use have a maximum beam of 48 feet.

b. Navigation Gate Opening. - The navigation opening will have a clear width of 90 feet and sill elevation of -18.0 m.s.l. This width will clear all barges in use, with towboat tied alongside and is the minimum acceptable to the New York Tow Boat Exchange. The width of 90 ft. was approved by the Office, Chief of Engineers, by 1st Ind. dated 21 June 1962 to letter of this office dated 15 June 1962 subject: "Navigation Gate Opening, Stamford Hurricane Barrier, Stamford, Connecticut".

c. Alteration of West Branch Navigation Channel. - The location of the pile wall at the upper end of the West Branch will reduce the width of the turning basin and modify the harbor line, as shown on Plate No. 3-7. Application for a change in the harbor line will be made after approval of this design memorandum.

17. Navigation Gate.

a. Selection of Type of Gate. - There are several types of navigation gates, including lift gates, tainter gates (lowering into recesses), sector gates and flap gates. Considering the width of opening and the elevation of rock foundation (el. -28±), a sector gate, as shown in the project document, or a flap gate would be most practical. A flap gate was selected on the basis of economy of construction and operation. A preliminary comparison of costs between a sector type gate and a flap gate for a 75 ft. gate opening, sill el. -18.0, made at the initiation of studies, is given below.

	Sector Gate	Flap Gate
Cofferdam	$ 400,000	$ 400,000
Excavation - earth	40,000	42,000
Excavation - rock	20,000	8,000
Concrete	585,000	438,000
Gate and Accessories	404,000	327,000
	$1,449,000	$1,215,000
Contingencies 15%	217,000	182,000
Total	$1,666,000	$1,397,000

On the basis of the above estimate, a flap gate would be more economical to construct.

A flap gate would be more economical to maintain than a sector gate, for it would be less subject to corrosion being normally in a "down" position, out of the critical tidal zone.

b. Description. - The gate leaf will be of high-strength, low-alloy steel, with skin plates on both faces, horizontal girders, and vertical diagrams. For general layout see Plate 3-24. It will be designed supported on three sides. It will be compartmented with provisions for dewatering the individual compartments to reduce hoist capacity and for floating into and out of place during installation or repair. The hoist will be located on the west abutment.

The gate will be operated by an electric motor driven hoist with permanently attached cables. Compressed air will be provided to dewater gate departments during hoisting operations. A diesel engine standby generator will be provided.

Abutments will be of mass concrete founded on sound rock. The gate sill will be of reinforced concrete, recessed for normal "down" position of gates.

A gated bypass conduit will be provided in the left abutment for care of interior drainage when the gate is closed for inspection or in advance of a forecast coastal storm. Pumping Station No. 2 will also be on the west abutment.

An operating house of reinforced concrete will house operating equipment and pumps.

Navigation guides and fenders will be provided in accordance with the requirements of the Coast Guard.

c. Construction. - A bypass navigation channel, 100 ft. nominal bottom width, bottom el. -12.0 m.s.l. will be dredged initially west of the gate site. The channel depth is sufficient for present barge traffic, except for loaded barges at low tide. Additional depth is not justified as there is only one round trip a day generally. A single-wall cofferdam will be specified because of the restricted area available for construction.

I. CLIMATOLOGY

18. General. - The temperate and changeable climate of the Stamford area is marked by four distinct seasons which are characteristic of the latitude of New England. The area lies in the path of the

"prevailing westerlies" and the cyclonic disturbances which cross the country from the west and southwest. It is also exposed to coastal storms which move up the Atlantic seaboard, some of which are of tropical origin. High winds, heavy rainfall and abnormally high tides are experienced in the hurricane months of August, September and October. Climatological records at the U. S. Weather Bureau station at Stamford are available since 1950, but due to the relatively short period of record and the fact that the station was relocated in December 1955, the data are not considered representative. However, records of precipitation and temperature for 69 years of record are available at Norwalk, Connecticut, 8 miles east of Stamford.

19. Precipitation. - The average annual precipitation at Norwalk is about 46 inches, which is rather evenly distributed throughout the year. Measurable precipitation occurs on an average in about one day in three. The heaviest precipitation recorded at Norwalk for a 24-hour period was 8.20 inches on October 16, 1955. This may have been exceeded during the hurricane of September 1938, at which time the rain gage was destroyed. Table I is a summary of the monthly precipitation data for Norwalk as measured over a period of 69 years through 1961.

TABLE I

Monthly Precipitation at Norwalk, Connecticut
(Depth in inches)

Month	Mean	Maximum	Minimum
January	3.56	7.35	.54
February	3.40	7.46	.49
March	4.20	12.42	.23
April	3.85	8.60	.77
May	4.01	10.78	.07 (1903)
June	3.31	10.54	.14
July	4.08	11.81	.65
August	4.78	15.80	.37
September	3.92	15.64	.23
October	3.68	17.23 (1955)	.31
November	3.77	8.86	.95
December	3.78	8.58	.85
Annual	46.32	62.93 (1955)	33.67 (1935)

20. Temperature. - The mean annual temperature of the Norwalk area is approximately 50°F. January is the coldest month with an average temperature of about 28°F. and July the warmest month with a mean temperature of about 72°F. Freezing temperatures are common from late November through March. The lowest temperature recorded in the Norwalk area was -22°F. on January 5, 1904 and January 28, 1935, and the highest temperature was 104°F. on August 26, 1948. Table 2 is a summary of mean monthly and maximum and minimum temperatures recorded at Norwalk, Connecticut, over a period of 69 years through 1961.

TABLE 2

Monthly Temperatures at Norwalk, Connecticut
(Degrees Fahrenheit)

Month	Mean	Maximum	Minimum
January	27.7	70	-22 (1)
February	28.2	70	-20
March	36.5	87	6
April	47.5	92	9
May	58.4	96	24
June	67.3	100	34
July	72.3	102	42
August	70.2	104 (2)	34
September	63.6	102	28
October	52.9	90	16
November	41.6	83	-4
December	30.6	71	-16
Annual	49.7	104	-22

(1) January 5, 1904 and January 28, 1935)
(2) August 26, 1948

21. Storm Rainfall. - The greatest rainfall associated with hurricanes in New England are those recorded for "Connie and Diane" in August 1955. Hurricane Connie, 11-15 August, caused rainfall varying from about four to six inches over Southern New England and ended a period of drought. The rainfall at Stamford equalled 4.2 inches in 24 hours and a total of 8.8 inches during the 3 day period of 12-14 August. During the following week, Hurricane Diane brought rainfall of 16-20 inches over many sections of Massachusetts and Connecticut. However, the Stamford area received a total of about 5 inches of precipitation within a 24-hour period.

The storm of 14-17 October 1955 was not classified as a hurricane, however, it caused five successive high tides at Stamford to an elevation of nearly 8 feet, m.s.l. approximately 4 ft. above normal. This storm produced a record rainfall at Stamford, totalling 13.29 inches in 73 hours. More than one half of this rainfall or 7.86 inches fell in a 12-hour period, including a one hour intensity of 2.07 inches and a one half hour intensity of 1.26 inches. The rainfall at Stamford and at nearby localities recorded during recent hurricanes and the storm of October 1955 are indicated in Table 3.

J. TIDAL HYDRAULICS

22. Tidal Hydraulics. - (See submittal dated 28 July 1962)

a. Stillwater level. - The design stillwater level for the Stamford Hurricane Barrier is comprised of a design surge of 10.4 feet concurrent with a mean spring high water of 4.4 feet above mean sea level, totalling to 14.8 feet above mean sea level.

b. Significant wave heights. - Significant wave heights and periods coincident with the design stillwater level of 14.8 feet mean sea level are as follows:

TABLE 3

HURRICANE AND OTHER STORM RAINFALL

Stamford, Connecticut and Nearby Locations

Accumulated Rainfall in Inches

Hurricane	Stamford, Conn. Max. (1) 24-hr.	Stamford, Conn. Total	Norwalk, Conn. Max. (1) 24-hr.	Norwalk, Conn. Total	Bridgeport, Conn. Max. 24-hr.	Bridgeport, Conn. Total	New Haven, Conn. Max. 24-hr.	New Haven, Conn. Total	Mineola, L.I. Max. 24-hr.	Mineola, L.I. Total
Sept. 1938	-	-	-	10.7	5.1	11.9	6.4	11.6	4.4	11.0
Sept. 1944	-	-	4.65	8.5	5.8	10.7	4.0	8.5	4.8	11.1
August 1954 (Carol)	2.3	2.6	2.7	3.1	1.6	1.7	2.75	2.75	2.5	3.25
Sept. 1954 (Edna)	3.7	4.0	4.4	4.4	3.5	3.5	5.55	5.55	4.5	5.35
August 1955 (Connie)	4.2	8.8	3.6	8.2	3.9	5.3	3.2	3.6	8.2	12.8
August 1955 (Diane)	3.2	4.7	4.1	5.2	1.9	3.0	3.2	4.3	1.1	1.5
Oct. 1955	9.6	13.29	8.2	13.0	5.8	7.15	3.2	5.9	2.3	4.0

(1) Non-recording station - values based on daily readings.

Location	Wave Height Ft.	Period (sec.)
West Branch Estuary	1 to 1½	5.5
West and East Branch	3	5.5
Westcott Cove	2	5.0

Maximum significant wave heights and periods occur one hour before the design stillwater level of 14.8 feet m.s.l. and are as follows:

Location	Wave Height Ft.	Period (sec.)
West Branch Estuary	1 to 2	6.0
West and East Branch	4	6.0
Westcott Cove	3	5.5

c. Wave Overtopping. - Quantities of wave overtopping and other details of Tidal Hydraulics are set forth in Design Memorandum No. 4 "Hurricane Tidal Hydraulics."

d. Departures from Interim Report. - In the survey report the design stillwater level of 16 ft. m.s.l. was determined by adding the storm surge of 10.4 ft. to a predicted maximum spring tide elevation of 5.6 ft. m.s.l. Since the coincidence of a hurricane surge with a high spring tide would be extremely rare, it is considered reasonable that the surge be added to a mean spring tide for design purposes which is accordance with subsequent decisions.

K. INTERIOR DRAINAGE

23. General. - At the time of a hurricane when all openings through the barrier are closed to prevent the entry of tidal water, ponding would result from coincident rainfall and overtopping from waves. An examination of historical records indicates that in past hurricanes the storms that caused the heavy precipitation did not create the serious tidal flooding, and conversely the hurricanes which caused the disastrous tidal damage did not produce unusually heavy precipitation. However, ponding of any magnitude cannot be tolerated in this area of high urban development. It is also recognized that upon completion of the project, the frequency of closure will increase and the duration of closure will be extended beyond periods represented by past floods. These would be due to the inadequacies in forecasting and also the possibility of abnormal tide occuring 24 to 48 hours preceding a hurricane.

24. Design Criteria. - For purposes of estimating drainage modifications and pumping requirements the following conditions were established:

(a) Pumping requirements. - A 10-year all season storm assumed coincident with the design hurricane surge. Overtopping during the design hurricane surge is too remote a possibility to be considered in the pumping requirements in combination with high interior runoff.

(b) New interior drains. - A 25-year storm for sizing new interceptors in the vicinity of the barrier.

(c) Drains through barrier. - A 100-year storm for sizing the gravity drains through the barrier.

(d) The peak discharge value was based on a 30-minute intensity (estimated concentration time) and the volume on an 12-hour duration as published in U. S. Weather Bureau Technical paper No. 40 dated May 1961.

25. Drainage Areas. - The terrain is characterized by rolling upland hills draining south to flats scarcely above maximum spring high tide elevation. The frequent combination of rapid storm runoff from the hills and high tide elevations produces troublesome backup and overflow of the storm drain.

The East Branch arm of the harbor will constitute a 54-acre pond behind the barrier, with significant damage beginning at about El. 6.5. The divide between the East Branch and West Branch drainage areas is at about elevation 7.5.

The Westcott Cove and West Branch areas contain no natural or potential ponding areas. The small swale existing back of the Muzzio boat yard in the Westcott Cove Area at the time of the Survey Report has been mostly filled. No consideration is given to restoration of the ponding because of its remoteness from existing drains and its small area. Damage from ponding would begin at about el. 7.0 and overland spill to the East Branch would occur when ponding reached a depth of 2 feet. In the West Branch area, a considerable area from Dyke Lane to Crosby Street is below maximum spring high tide elevation and is now protected by an inadequate dike and pumping installation.

The drainage areas affected by the proposed barrier are indicated on Plate No. 3-22. It should be noted that there are a few areas in which the existing drainage system flowed in different

directions than the overland flow from the natural topography. For purpose of analyzing the individual pumping station requirement, it was assumed that 50 percent of these areas would be contributing to the respective stations.

26. Storm Drains. - There are existing 15-inch and 36-inch drains in Atlantic Street which presently discharge, by gravity, into West Branch in the vicinity of the Hartford Electric Light Company. These two drains will be combined into a single 42-inch drain and diverted to Pump Station No. 1. A new drain, connecting to the existing drains will be installed in the oil company area just north of the Hartford Electric Light Company.

Storm drains converge in the Pacific Street area at the small existing pumping station at Crosby Street. A separate system drains the area back of Dyke Lane to 2 flap gated outlets thru a make shift dike. The low point of this area is at the intersection of Crosby and Pacific Streets where the ground is at an elevation of less than 2.0 m.s.l., which is below mean high tide. At present a small drain leads from Pacific Street to the Dyke Lane system. When there is storm runoff a portable pump is operated to pump drainage from Dyke Lane and a 22 cfs pumping station at Crosby Street discharges thru a 24" force main at the Hartford Electric Light Co. docks. This installation is unable to care for runoff adequately and the 24" drain is too weak for the pumping pressure.

The City has informally requested that the discharge system be replaced in connection with this project, with the understanding that costs in excess of project costs will be reimbursable.

Two general alternatives were considered for carrying out this request; the first being a pumping station at the barrier on Dyke Lane with a 72-inch storm drain from Pacific Street, and, second, a pumping station at the location of the existing station on Pacific Street with a gated 48-inch force main thru the barrier. A 48" force main would be easier to construct, but the pumping installation required to overcome head losses in the force main would increase overall cost markedly. Therefore the pumping station will be located at Dyke Lane with a gravity flow conduit from Pacific Street. Effective drainage cannot be maintained by gravity flow thru the dike during the "high" portion of the tide cycle or during a heavy runoff. Flap gates could be installed to cut off backflow during high tide, but would not be fully reliable, and all flow will be pumped.

Back of the inside toe of dike just east of Shippan Avenue from Seaview Street, a gravity interceptor drain will be installed to

carry the flow to Pump Station No. 3. The existing 24-inch drain to Rippowam Road will also be connected to the Pump Station and a 48-inch outfall drain will be installed from Pump Station No. 3 to Westcott Cove.

An interceptor drain will be installed back of the inside toe of dike, in the Cummings Park area from Seaview Street, connecting to Pump Station No. 4 which will intercept an existing 36-inch drain. A 60-inch outfall will extend to Westcott Cove.

27. Pumping Requirements

a. General. - The peak rates of inflow to the individual areas were developed from the rational formula Q=CIA with "C" values varying between 0.4 and 0.6. Where necessary the hydrographs were developed from synthetic unit-hydrographs and then routed and combined for the larger areas. The following is a summary of the peak inflows and the selected pumping capacities to be used against the design stillwater level.

Pumping Station	Drainage Area	Peak Inflow	Selected Pumping Capacity
	Acres	c.f.s.	c.f.s.
#1	197.5	588	516 (a)
#2	1206	1070	100 (b)
#3	38.7	51	50
#4	112.4	147	140

(a) Includes 194 c.f.s. required for cooling water.
(b) Required to maintain water surface below elevation 6.0 mean sea level.

b. Pumping Station Capacity. - The considerations used in determination of pumping requirements are as follows:

(1) Pumping Station No. 1 - As stated previously, the 194 c.f.s. cooling water discharge of the Hartford Electric Light Company plant will be pumped thru Pumping Station No. 1 when the barrier is operating. Local runoff from the entire area back of the West Branch will be pumped at this station. Due to the low ground elevation regular pumping at other than storm tide periods will be required.

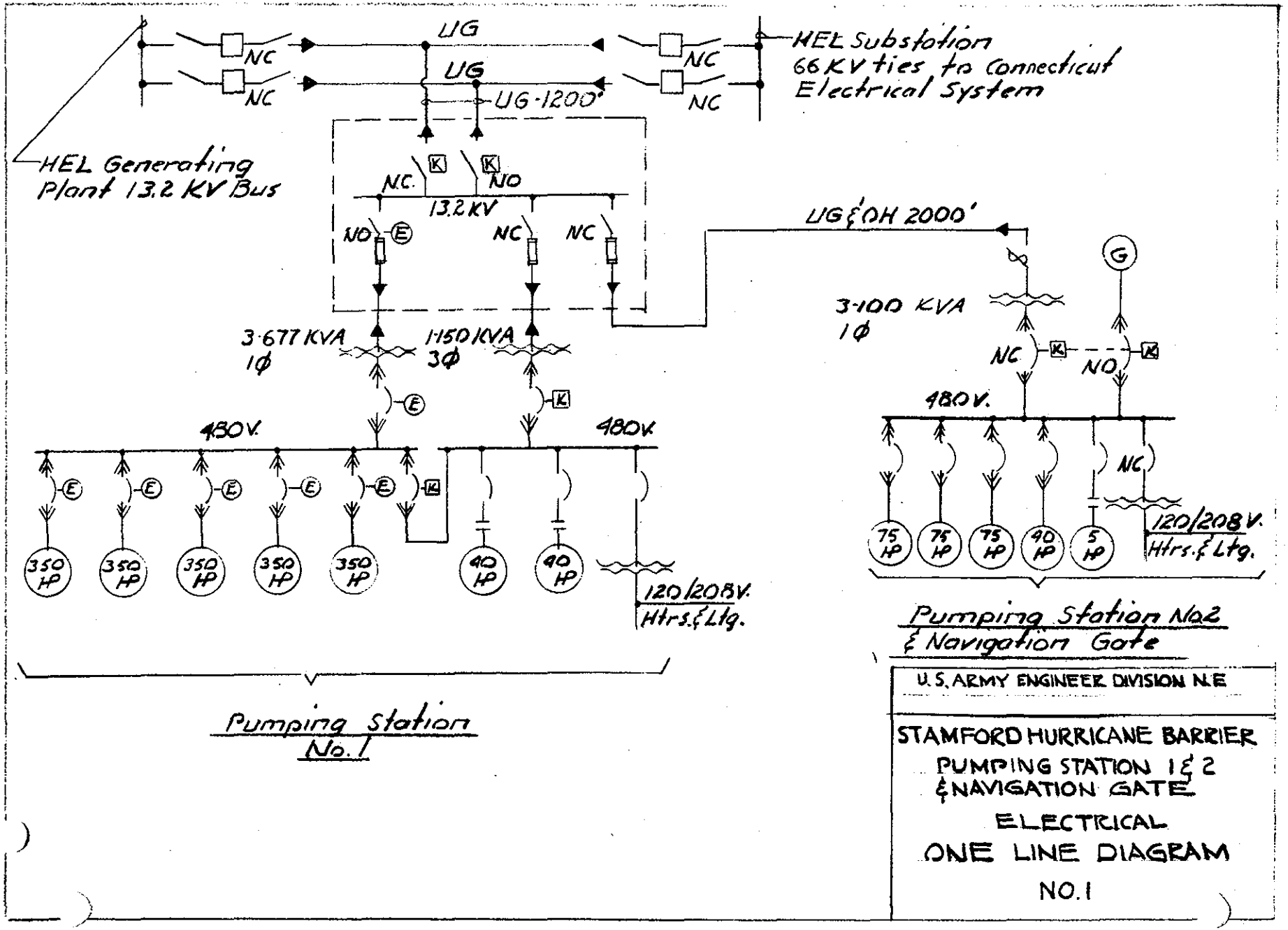
(2) Pumping Station No. 2 - The effectiveness of the existing storage in the East Branch during a hurricane is a function of the

tide level at time of closure of the navigation gate. If closure can be made at zero mean sea level, a coincident 10-year storm would not create significant damage. However, in a recurrence of a storm as experienced in October 1955 when five successive tides were about 4 feet above normal, damages of about $25,000 would be experienced. This is based on an assumed closure of the navigation gate with the tide at elevation 2.0 m.s.l., which results in a maximum ponding elevation of 7.5 m.s.l. If the gate was closed at mean sea level the resultant elevation would have been 6.6 feet m.s.l. which represents about $5,000 in damages. It cannot be said with assurance that closure could be made under favorable conditions. Recognizing the risk involved if closure is not made at the lower tide levels, which could readily occur with inadequate hurricane forecasting, and considering the fact that a pumping station could readily be incorporated into the navigation gate structure, it was decided that provision would be made for some moderate rate of pumping. Assuming closure at elevation 2.0 m.s.l. the adopted pump capacity of 100 c.f.s. will provide for the 10-year storm without exceeding elevation 5.5 m.s.l. at which stage the estimated damage will be less than $1,000. If a 25-year storm were to occur with the barrier closure, the adopted capacity would allow the water surface to rise to elevation 6.2 which would create about $2,000 in damages. With the pool held below elevation 6.0 m.s.l. there will be additional benefits due to an improved gradient in the existing drains.

(3) Pumping Station No. 3. - If no pumps are provided, the ponding that would be experienced with a 10-year storm coincident with barrier closure would be about elevation 8.5 m.s.l. which represents about $25,000 in damage. This is exclusive of damages outside the ponding area due to the drains becoming surcharged.

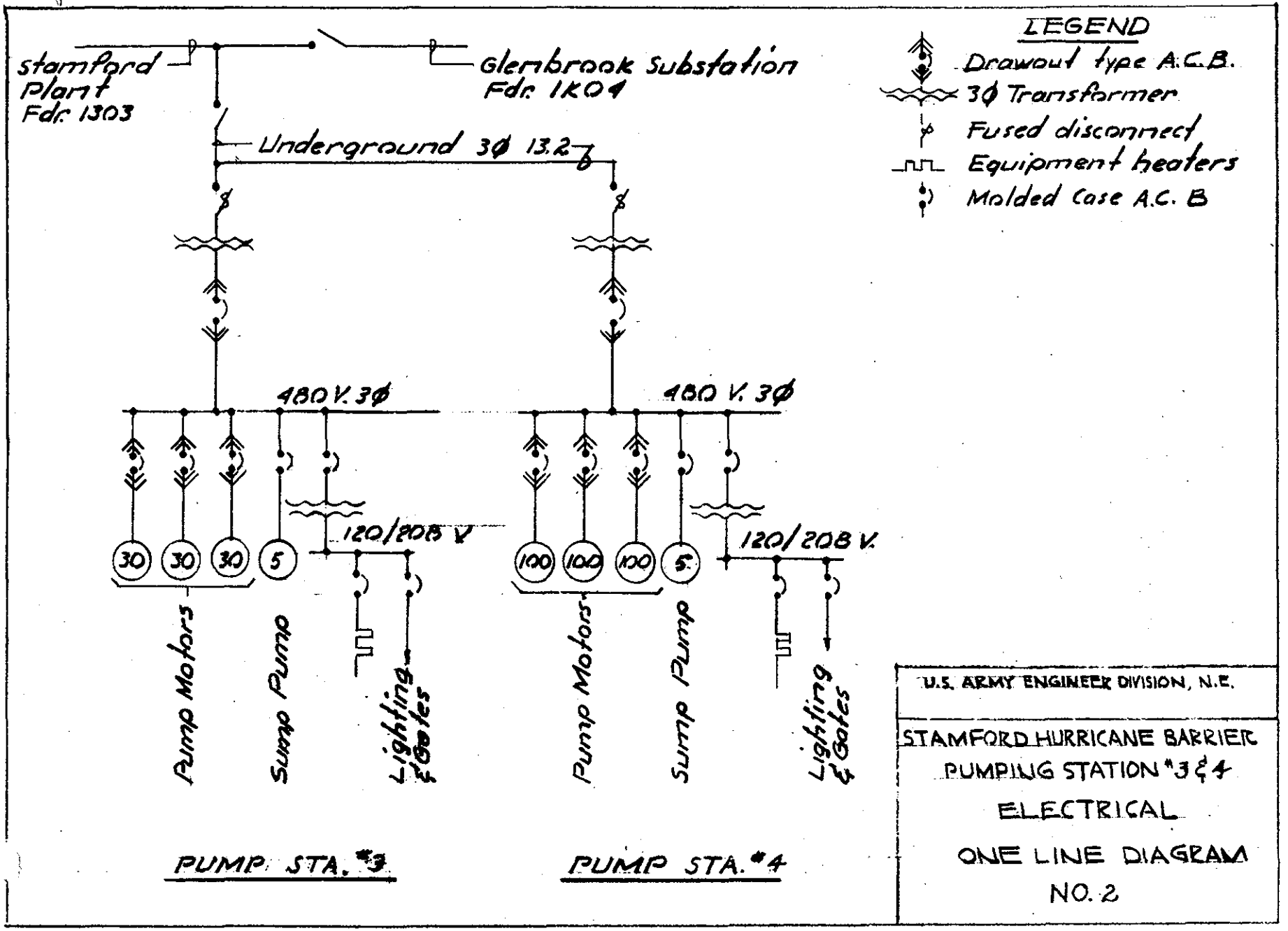
(4) Pumping Station No. 4. - If no pumps were provided at this location, ponding would exceed elevation 9.0 m.s.l. at which level the flow would drain into the East Branch. If this were permitted, the damages experienced would exceed $30,000.

(5) Alternate Plans, Westcott Cove Area. - Alternate plans considered combining the drainage of Stations Nos. 3 and 4, but inadequate gradient plus length of pipes required made this plan more costly. Another plan considered the diversion of flow from these two areas into the East Branch and increasing the capacity of Pumping Station No. 2. This plan again was found to be more costly for the same reasons.



U.S. ARMY ENGINEER DIVISION N.E

STAMFORD HURRICANE BARRIER
PUMPING STATION 1 & 2
& NAVIGATION GATE
ELECTRICAL
ONE LINE DIAGRAM
NO. 1


Stamford Plant Fdr. 1303
Glenbrook Substation Fdr. 1K04
Underground 3Ø 13.2
480 V. 3Ø
480 V. 3Ø
120/208 V
120/208 V.
30
30
30
5
100
100
100
5
Pump Motors
Sump pump
Lighting & Gates
Pump Motors
Sump pump
Lighting & Gates
PUMP STA. #3
PUMP STA. #4
LEGEND
Drawout type A.C.B.
3Ø Transformer
Fused disconnect
Equipment heaters
Molded Case A.C. B
U.S. ARMY ENGINEER DIVISION, N.E.
STAMFORD HURRICANE BARRIER
PUMPING STATION #3 & 4
ELECTRICAL
ONE LINE DIAGRAM
NO. 2

28. Description of Pumping Stations. - The pumping stations will be of the same general type utilizing electric motor driven vertical axial flow pumps. The pumps will be suspended in a normally dry sump adjacent to the gravity flow conduit; motor operated sluice gates will be provided to close the gravity flow conduit, and open the entrance to the pump when pumping operations are required. The structures will be of reinforced concrete. Plate No. 3-23 showing preliminary arrangement of Station No. 1 is typical of all stations. Piling will be provided where foundations conditions require. Selection of pumps will provide an optimum combination of low first cost and necessary flexibility and reliability. Three pumps are selected for Pumping Stations Nos. 2, 3, and 4. Because the large amount of storage it may prove more economical to provide 2 pumps at Pumping Station No. 2. Due to the lack of an appreciable storage at Stations Nos. 3 and 4, provisions for operation under very low inflow conditions will be provided by the use of a variable speed motor on one pump of each of these stations.

29. Selection of Pump Drive Equipment. - A cost comparison to determine the most economical method of pump drive consistent with the reliability requirements for each of the pumping stations and navigation gate was made. Based on these comparisons, all installations will have electric motor drives.

A cost comparison was made to determine the most economical voltage for operation of each of the pumping stations. Pump motors in station 1 will be operated at 480 volts. Gate operators, sump pump, equipment heaters and lighting will operate at 120/208v. The two 40 hp pumps together with the aforementioned miscellaneous loads will be supplied from a three phase subway type transformer rated 13,200/480v. The subway type transformer was selected to avoid the necessity of normally energized open primary connections in this area where squirrels have caused outages to nearby utility substations.

Pump motors in stations 2, 3 and 4 will be operated at 480v with the auxiliary equipment supplied from a three phase 480/208/120v transformer.

30. Power Supply. - Power supply for the No. 1 pumping station will be obtained from the Hartford Electric Light Company's underground 13.2 kv tie feeders between the generating plant (capacity 90MW) and the 66/13.2 kv substation which is interconnected by two 66 kv transmission lines to the Connecticut power grid. Two independent 100% rated underground feeders will terminate in outdoor metal enclosed switching equipment located adjacent to the pumping station. The transformer bank (3-677 kva) serving the 5 main pumping motors

would be normally deenergized. One normally energized circuit will serve, by aerial cable, pumping station No. 2 and the navigation gate. A standby diesel engine generator set will be provided for operation of the navigation gate in case of failure of the single circuit feeder but will not be sized to accommodate the pump motors in Pumping Station No. 2. (See Diagram 1)

Pumping Stations Nos. 3 and 4 will be served from an existing 13.2 kv feeder emanating from the generating plant 7000 feet distant with an alternate source available from a separately fed substation. (See Diagram 2)

Since the temporary loss of power to Pumping Stations 2, 3 and 4 would result in minor property and nuisance damage, these will be served by a single feeder without standby power.

L. RELOCATIONS

31. Utilities. - Those portions of existing water, sewer, gas, electricity, telephone, and storm drainage systems passing through the barrier will be gated and modified as necessary for the operation and safety of the project.

Modifications of the storm drainage system outside the barrier limits will be included in the work and costs included as part of the local costs of the project.

The construction of a new 72-inch drain from the intersection of Crosby and Pacific Streets to Pumping Station No. 1 is considered a local responsibility which cannot be charged to the project because it is a replacement of a presently inadequate drain.

32. Streets and Parking Areas. - Highways and parking areas will be relocated or realigned as necessitated by the construction of the barrier. Construction will be included in the general contract for construction of the barrier as a local responsibility. Ramps are included as an integral part of the dikes.

M. FOUNDATIONS, EMBANKMENTS AND CONSTRUCTION MATERIALS

33. Geology. - Stamford Harbor lies on the seaboard lowland of the New England Physiographic province. Bedrock (schist) outcrops are abundant, overburden is quite thin and consists of bony gravels and sands, marsh deposits, and a thin veneer of till which occurs on the sides of rock hills.

Subsurface conditions along the West Branch and across the main harbor are generally depicted on Plates 3-5 and 3-6, respectively.

Detailed Information concerning geological conditions will appear in Design Memorandum No. 1, SITE GEOLOGY.

34. Foundations. -

a. General Conditions. In general, the foundation areas along the project site have undergone considerable alterations in the past through the building of seawalls and piers, the artificial filling of tidal marshes, and the disposal of industrial wastes. At the present time, the foundation conditions at the Hartford Electric Light Company yard are being altered through the removal of an upper deposit of granular materials and its replacement with fly-ash, and the filling of a tidal inlet at the south end of the yard.

b. West Branch Alignment. The structures at the West Branch will extend along a flat area flanked at both ends by higher grounds containing rock outcrops. The foundation above the tidal range consists mainly of artificial fill of various types. The fill material is generally 5 to 10 feet thick and consists of sand, gravelly sand, fly-ash, coal, wood chips, rubbish or mixtures thereof.

Organic silt and fibrous peat deposits 2 to 8 feet thick underlie the artificial fill materials. Immediately outboard of the seawalls and piers, organic silt deposits 3 to 10 feet thick are present below the harbor bottom.

Beneath the organic silt deposit there are strata of gravelly silty sand, silty sand, and silty sandy gravels. These strata overlie bedrock at both ends of the West Branch structure alignment. Explorations indicate these strata to exceed a thickness of 35 ft. in the middle of the alignment.

The overburden thickness along the proposed bulkhead alignment varies from 10 feet at its north end to 30 feet at its south end.

c. East Branch Harbor Barrier. The barrier will extend across a wide flat valley flanked by high rock outcrops on the west and by a glacial till formation on the east. The foundation areas outside of the channel are former tidal marshes which have been artificially filled with gravelly silty sand, silty sandy gravel, fly-ash, shells, rubbish or mixtures thereof. In the harbor bottom and beneath the artificial fill there are deposits of organic silt which vary in thickness from 1 to 8 feet.

Beneath the organic silt deposit there are strata of silty sand, gravelly silty sand, silty sandy gravel, and sandy silt. Glacial till consisting generally of silty sandy gravel, overlies bedrock directly beneath these strata. The maximum foundation thickness overlying bedrock is 30 feet.

d. Bypass Channel. The soil formation which is to be excavated for the construction of the proposed bypass channel consists of a top deposit 2 to 5 feet thick of organic silt underlain mainly by silty sandy gravel.

e. Westcott Cove Dike. The dike alignment crosses tidal marsh areas which have been artificially filled with sand, gravelly sand, silty sand, and rubbish. The underlying marsh deposits are organic silt and peat varying in thickness from 1 to 7 feet. Flanking both ends of the dike there are glacial till formations. Rock outcrops are visible at the north end of the dike.

Underlying the artificial fill and tidal marsh deposits there are strata of sand, silty sand, and gravelly sand.

f. Structures. The navigations gate structure will be founded on and in sound bedrock. The anchored concrete sheet pile wall will be driven to bedrock or thin glacial till overlying bedrock. Piling will be provided under Pumping Stations No. 1 and No. 2.

35. Embankments. - Several dike embankment sections have been selected as shown on Plate 3-18 in accordance with foundation and construction conditions. In general, the dike embankments will be a compacted impervious fill protected against wave action on the ocean side by layers of stone protection. The land side of the embankments will be topsoiled and seeded to provide turf that will withstand minor overtopping and will be appropriate to the public recreation areas. In general, control of seepage through and under the embankments is provided by a relatively flat landside embankment slope and a pervious land side toe section. Soft soils and open trash will be removed from the foundation areas. An exploration trench has been provided in the foundation area for the full length of the Westcott Cove Dike for the purpose of locating existing buried pipes structures, open trash, and open gravels. At the water crossings, the dike sections below elevation +2 M.S.L. consist mainly of dumped impervious earth fill confined by rock toes which will permit the most economical construction.

The dike embankment sections have been designed on the basis of the impervious fill composed of gravelly silty sand with 15 to

40 percent silt which is available from land sources. To provide such material will require either truck transportation through residential areas or shipment by railroad.

Embankment design and construction studies have been made utilizing earth fill materials obtained by dredging in Westcott Cove. It was concluded from the studies that it is more economical and practical to utilize earth fill material from land source.

36. Sources of Dike Materials.

a. Impervious Fill Material. - Suitable impervious fill for the selected embankment sections can be obtained from glacial deposits located to the north and to the east of Stamford within a 15 mile radius, possible sources within a 5 mile radius are presently being investigated.

b. Other Earth Fill Materials. - Other available earth fill materials not suitable for the present embankment designs exist underwater in Westcott Cove and in settling basin areas of gravel processing plants located at Port Washington, Long Island, New York. Preliminary probings and materials from previous dredging operations indicate that the materials in Westcott Cove are variable sands not covered with soft materials. The materials at Port Washington are waste fines and consist of silts, silty fine sands and clayey silts. Barge facilities are available at Port Washington.

c. Granular and Gravel Fill Materials. - Granular and gravel fill materials are available from commercial and potential sources located to the northeast of Stamford within a 20 mile radius and from commercial sources by barge located on Long Island, New York.

d. Stone Protection. - High grade traprock for stone protection may be obtained commercially from Branford, Connecticut, to the East, and the lower Hudson River area on the west, a distance of about 40 miles with transportation direct to the site by either barge or rail.

e. Concrete Aggregates. - Commercial sources of concrete aggregates within an economic haul distance of the site have been sampled and are being tested. Detailed discussion of concrete aggregates will be included in Design Memorandum No. 2 "Concrete Materials".

SECTION N - REAL ESTATE

37. General. Land requirements and appurtenant property rights will be acquired by local authorities.

38. River Area. No acquisition is necessary for construction components occupying river or harbor area.

39. Land Requirements. It is assumed that required land interests will be acquired under permanent easement wherever this estate is adequate to serve project requirements. In those instances where improvements must be removed or access will not be available, fee acquisition will be recommended. The area is generally densely built up with industrial and commercial uses along the waterfront. A large portion of land requirements lie within city-owned public parks.

Total land requirements are estimated at 18.5 acres in fee and permanent easement and 2.0 acres under temporary easement. There will be five residential properties which will require removal and two others will be reduced in value.

Severance damages are expected to be substantial due largely to impairment of access to some waterfront properties.

40. Special Benefits. Near the westerly end of the project area, a dike will run along the water frontage of two oil companies and the Hartford Electric Light Company and run inland across land of the latter company to Dyke Park. Loss in value attributed to the land required and severance damages is considered relatively small and is exceeded by the special benefits afforded to these companies by the proposed protection. Two alternate alignments were considered for traversing land of the Hartford Electric Light Company. An "outboard" alignment favored by the Company would undoubtedly reduce severance damage in comparison to the "inboard" alignment proposed, but based on preliminary data available, special benefits exceed property value loss attributable to either alignment. It is currently contemplated that borrow requirements and material storage areas for construction will be furnished by the Contractor.

Estimate of real estate requirements and costs are subject to refinement when adequate tract data is available. Details of the proposed real estate acquisition program will be set forth in the forthcoming Design Memorandum for Real Estate No. 6.

41. Valuation:-

Total Estimated Land Costs	$ 280,000
Severance Damages	120,000
Contingencies (15% of above)	60,000
Acquisition and Administrative Expenses	40,000
Total	$ 500,000

O. VIEWS OF CONSULTANTS

42. Views of Consultants. No consultants have been used in the preparation of this design memorandum.

P. COORDINATION WITH OTHER AGENCIES

43. Coordination with Other Agencies. Coordination with Federal, State and other agencies, when appropriate, has been carried out.

Preliminary plans of a projected urban renewal project in the vicinity of Atlantic and Main Streets, north of the New York, New Haven and Hartford Railroad have been discussed with representatives of the City and its Architect-Engineer. The urban renewal plans contemplate controlling and eliminating local flooding from backwater of a storm drain, which is a matter outside the scope of the hurricane barrier project. It would also raise the area above the elevation of tidal floods of record. Ultimately the total valuation will be greater due to higher utilization. About 10% of the benefits to be derived from the hurricane barrier would be affected. The urban redevelopment project would eliminate damages in the lower ranges, but the ultimate gain at higher levels as new modern buildings are erected should more than offset the decrease.

Q. ECONOMICS

44. General. The City of Stamford, Connecticut is subject to heavy losses from hurricane tidal flooding and flooding accompanying the combination of southeasterly storms and extreme tides. In both September 1938 and August 1954 water depths of 3 to 5 feet were experienced in the completely built over South End of the city and along the banks of the harbors, coves and streams of the area.

August 1954 losses in Stamford amounted to $3,430,000. Since that time there has been lessened economic activity in one large plant and some protective measures have been carried out elsewhere. A recurrence of August 1954 flood heights under 1962 economic conditions would cause losses estimated at $3,250,000 without protection. The project would eliminate ~~$2,940,000~~ 2,770,000 of these losses.

Annual benefits were derived for the project by determining the difference between annual losses under pre-project conditions and the annual losses to be expected after the project is completed. A review of business, industrial and population trends in Stamford and its environs indicate a continuing growth, which will be reflected in property susceptible to tidal flood damage due to redevelopment

for commercial and industrial uses. The project benefits have been adjusted to reflect this growth over the life of the project. Average annual benefits so derived amount to $493,000 (@ 2⅝%) at 1962 price level.

In addition to damages prevented benefits the project will eliminate certain emergency costs presently incurred by industrial and commercial interests upon receipt of hurricane warnings. Such warnings are estimated to occur 4 times in any 10 year period. Among costs involved are sand bagging and the temporary removal of goods and equipment from space likely to be flooded. Such costs are estimated at $25,000 at 1962 price level on an average annual basis.

The project will also make possible the development of 18.4 acres of land to higher usage when the threat of flooding has been removed. On an annual basis the value of this enhancement is estimated at $9,000. The total annual benefits are ~~$517,000~~ $527,000

45. Benefit-Cost Ratio. Annual cost as computed in Paragraph 48 is $269,000. The ratio of benefit to cost is 1.92 to 1.

R. COSTS, CONSTRUCTION, OPERATION

46. Estimate of Cost.

a. Estimated Project Cost

(1) Lands and Damages	$500,000
(2) Preauthorization Studies	50,000

	Est. Quantity	Unit	Unit Price	Amount
(3) Construction (Dikes, Ramps, & Earth Work)				
Excavation, Earth (Water Area)	102,000	C.Y.	$ 1.50	$153,000
Excavation, Earth (Land Area)	42,000	C.Y.	1.50	63,000
Excavation, Rock	4,400	C.Y.	5.00	22,000
Earth Fill, Impervious	118,000	C.Y.	2.50	295,000
Earth Fill, Random	23,500	C.Y.	0.50	11,750
Earth Fill, Granular	64,500	C.Y.	2.00	129,000
Stone Prot.(450#-700#)	12,500	C.Y.	10.00	125,000
Stone Prot.(2"-80#)	21,000	C.Y.	9.00	189,000
Rock Fill	23,100	C.Y.	8.00	184,800
Rock Filter	2,700	C.Y.	8.00	21,600

46. Estimate of Cost(Cont'd)

	Est. Quantity	Unit	Unit Price	Amount
Gravel Bedding	13,000	C.Y.	$ 4.00	$ 52,000
Gravel Fill	23,500	C.Y.	4.00	94,000
Topsoil	4,200	C.Y.	5.00	21,000
Gravel - Road Base	3,500	C.Y.	4.00	14,000
Road Surfacing, 3" A.C.	8,500	S.Y.	2.00	17,000
Road Surfacing, Dbl. Bit. Treatment	1,700	S.Y.	0.50	850
Curb - A.C.	6,000	L.F.	0.50	3,000
Guard Rail	4,000	L.F.	2.50	10,000
Fencing	1	Job	L.S.	2,000
Razing of Buildings	1	Job	L.S.	5,000
			Sub-total. .	$1,413,000
Walls				
Anchored Pile Wall				
Soldier Piles	9,500	L.F.	$18.00	$171,000
Panels, Reinforced Concrete	1,000	C.Y.	60.00	60,000
Panels, Prestressed Concrete	50,000	S.F.	4.00	200,000
Ties, Top and Bottom	135	Sets	700.00	94,500
Cantilever Wall				
Concrete, Reinforced	350	C.Y.	80.00	28,000
Cooling Water Intake Conduit	1	Job	L.S.	50,000
Cooling Water Discharge Conduit	1	Job	L.S.	40,000
Docking Aids, Oil Fills, Gate,Etc.	1	Job	L.S.	18,000
			Sub-total. .	$661,500
Navigation Gate				
Cofferdam	1	Job	L.S.	$394,000
Concrete, Reinforced	1,015	C.Y.	$65.00	66,100
Concrete, Mass	5,370	C.Y.	55.00	295,350
Flap Gate & Accessories	553,000	Lbs.	0.35	193,550
Operating Equipment	1	Job	L.S.	70,000
Diesel Electric Standby	1	Job	L.S.	20,000
Miscellaneous	1	Job	L.S.	15,000
			Sub-total. .	$1054,000

Pumping Stations

Sta. No.	Earthwork Structure	Electric Supply	Electric Equipment	Pumps, Gates, Acc.	Total
1	$ 190,000	58,000	94,000	258,000	$ 600,000
2	8,000	26,000	51,000	58,000	143,000
3	23,000	14,000	28,000	24,000	89,000
4	48,000	16,000	45,000	70,000	179,000

Sub-total. . . $1011,000

Modification of Utilities - Local Responsibility

Atlantic St. Storm Drain Interceptor	$ 18,000
Lateral Storm Drain to Pumping Sta. No.3	24,000
Lateral Storm Drain to Pumping Sta. No.4	9,000
Modifications of Telephone & Elect. System	16,000
Cummings Park Parking Area Relocations	31,000

Sub-total. . . $ 98,000

Modification of Utilities - Federal Responsibility

Care of Water, Gas, & Sanitary Sewer Lines thru Dike	$ 29,000
Outfall from Pumping Station No. 1	33,000
Outfall from Pumping Station No. 3	12,000
Outfall from Pumping Station No. 4	12,000
Cooling Water Discharge Conduit	155,000

Sub-total. . . $ 241,000

Sub-total Construction Cost . . . 4,478,500

Contingencies, 15% . . . 671,500

Total. . $ 5,150,000

(4) Engineering and Design 437,000

(5) Supervision and Administration 445,000

Total Project Cost (Federal and Non-Federal) $ 6,582,000

Cost Estimate (Cont'd)

(6) Pacific Street Storm Drain Interceptor (replaced at request of City)	$ 270,000
Total Project and Non-Project Cost	$6,852,000

b. Apportionment of Costs. - The apportionment of costs between Federal and local agencies is as follows:

Federal Funding	$3,742,000
Non-Federal Contribution	2,840,000
Total Project Cost	$6,582,000
Non-Project Cost (City of Stamford)	$ 270,000

The Non-Federal contribution is estimated as follows:

Lands and Damages	$ 500,000
Modification of Utilities (Includes contingencies, engr., and overhead)	132,000
Local contribution in lieu of cost of Maintenance and Operation of Navigation Gate (See Para. 48c)	880,000
Local contribution on net total Project Cost: 30% x $6532,000, less Lands and Damages and Local Utility Mod.	1,328,000
Total	$2,840,000

c. Comparison with Project Document Estimate. - Tabulated below is a comparison of costs with the project document estimate:

	Project Document	General Design Memorandum
Lands and Damages	$ 150,000	$ 500,000
Pre-authorization Studies	50,000	50,000
Construction:		
Dikes, Ramps, and Earthwork	1,509,000	1,413,000

Revised 4 January 1963

Comparison with Project Document Estimate (Cont'd)

	Project Document	General Design Memorandum
Walls	$ 507,000	$ 661,500
Navigation Gate	1,430,000	1,054,000
Pumping Stations	260,000	1,011,000
Utilities	165,000	308,000
Parking Areas	-	31,000
Contingencies	769,000	671,500
Total Construction	$4,640,000	$5,150,000
Engineering and Design	417,000	437,000
Supervision and Administration	403,000	445,000
Total Project Cost	$5,650,000	$6,582,000
Federal Cost	3,094,000	3,742,000
Local contribution	2,556,000	2,840,000
Annual Charges:		
Federal	144,000	148,700
Local	104,000	129,500

In addition, a local contribution of $270,000 for the Pacific Street storm drain interceptor will be made.

The explanation of changes in the project is given in pertinent paragraphs of this Design Memorandum. Major changes in project cost arising from the revisions are as follows:

(1) Cost of lands and damages revised due to change in section of dikes, to straightening of alignment in places, and to recent construction of a large marina on the East Branch, amounting to an increase of + $ 350,000

(2) Alignment and type of construction changes at the upper end of the West Branch. This results in a substantial increase in cost over the prior estimate, but after full provision for problems arising from construction on the prior alignment the actual difference in cost would be slight.

(3) Alignment changed at the south end of the Hartford Electric Light Company at a reduction of - $ 150,000

(4) Alignment changed to project Mitchell Street area + $ 29,000.

(5) Navigation gate changed from a 75 ft. sector gate to a 90-ft. flap gate at a reduction of - $ 500,000.

(6) Shallower and shorter temporary bypass channel at a reduction of - $ 170,000.

(7) Additional pumping installation for interior drainage and for care of Hartford Electric Light Company cooling water at an increase of + $1,045,000.

(8) Restudy of utility modifications and addition of parking areas relocation, resulting in an increase of + $ 240,000.

(9) Reduction of contingency factor from 20% to 15% - $ 97,500.

47. Schedule for Construction.

a. Design. - Design memoranda are scheduled for completion by February 1963. Contract plans and specifications are scheduled for completion by October, 1963.

b. Construction. - Construction of the project will require two construction seasons, contingent upon the availability of necessary funds. All construction will be accomplished under a single contract presently scheduled for award in February 1964.

Work may be initiated and continued at several areas concurrently, but care must be given to scheduling construction at the navigation gate, the major item of construction.

In the first construction season all foundation excavations for dikes and pumping stations, and dredging of the bypass channel and dike excavation in the East Branch will be completed. The navigation gate area will be cofferdammed, and excavation in the cofferdam will be completed.

Concrete placing for pumping stations and the navigation gate will be initiated in the first construction season and completed

in the second season. The structural navigation gate and hoist and pumping equipment will be installed late in the second season after the concrete structures are complete.

The pile wall construction will be initiated as soon as materials are at hand and the wall will be virtually complete at the end of the first construction season.

Construction of the earth dikes will be coordinated with other operations and will be complete in 2 seasons.

Bar graphs are shown on Plate 3-28, "Detailed Progress Schedule."

c. Funds Required. Design will continue thru Fiscal Year 1963 and will be complete by November,1963. The completion of design, lands and damages, relocations and initiation of construction is based on funding of 800,000 for Fiscal Year 1964; and on the assumption that additional funds will be appropriated as required. It is estimated that project funds will be required approximately as follows:

Fiscal Year	Funding
1964	$ 800,000
1965	3900,000
1966	1482,000
	$6,182,000
Funding to FY 1963	400,000
Total. . .	$6,582,000

48. Maintenance and Operation.

a. Project Plan. - It is assumed that the maintenance and operation of the navigation gate, including abutments will be a Federal responsibility while operation and maintenance of Pumping Stations and dikes will be a local responsibility. Operation of the project will be coordinated between Local and Federal agencies. A small crew of three men would be employed on a permanent status for operation, inspection, and minor repairs. Major repairs would be contracted out.

b. Annual Costs. - The estimated annual cost is $278,200 as shown on the following computations:

(1) Federal Investment

a.	Federal First Cost	$3,742,000	
b.	Interest During Construction (1ax2875x½T)(T=2yrs)	108,000	
c.	Total Federal Investment		$3,850,000

(2) Federal Annual Charges

a.	Interest (1cx0.02875)	$ 110,800	
b.	Amortization (1cx0.00179)	6,900	
c.	Maintenance and Operation	31,000	
d.	Total Federal Annual Charges		$ 148,700

(3) Non-Federal Investments

a.	Contributed Funds	$2,208,000	
b.	Lands, Easements, & Rights-of way	500,000	
c.	Improvements by Local Interests	132,000	
d.	Total Non-Federal First Cost		$2,840,000
e.	Interest During Construction (3dx0.033x½T)		94,000
f.	Total Non-Federal Investment		$2,934,000

(4) Non-Federal Annual Charges

a.	Interest (sfx0.033)	$ 96,800	
b.	Amortization (3fx0.00134)	3,900	
c.	Maintenance and Operation	28,800	
d.	Total Non-Federal Annual Charges		$ 129,500

(5) Total Annual Charges (2d+4d) ($148,700+129,500) $ 278,200 ←

c. Maintenance and Operation Costs. - Assume 1 crew of 2 permanent employees supplemented by 2 extra laborers 1 month annually, exclusive of Federal operation of the navigation gate. (Assume 52 hours, extra-manning, hurricane season, by the permanent employees.

(1) Salaries

2-WB Employees	
2 (52 x 8 + 52)	$ 13,000
2-WB Laborers, 1 month	
2 (40 x 4)	1,200
	$ 14,200

Maintenance and Operation Costs, Cont'd

F.I.C.A., etc.	7.8%	$ 1,100	
Wage Bond increase (annual)		700	
		$ 1,800	
	Total		$16,000

(2) Federal Costs $31,000

Annual costs of maintenance and operation of the navigation gate as shown in the Interim Report are retained pending completion of design and restudy of costs.

Maintenance and Operation Costs, Cont'd

(3) Non-Federal Costs

Salaries		$16,000
Maintenance		
Concrete 1, 840 cy x $60 @ .0035x1.18	$ 320	
Stone 52,000 by x .03/50 @ 10.00	300	
Pile Wall 543,000 x .0025	1,360	
Pumping Equipment		
Mechanical) $860,000 x .004 Electrical)	3,440	
Electrical service (testing, lighting, exclusive of more or less regular use of Pumping Stations)	500	
Phone, radio, small tools	480	
Vehicles	500	
		6,900
Contingencies 15% x (16,000+6,900)		3,400
Indirect Costs		2,500
Total		$28,800

(4) Capitalized Value

Capitalized value of maintenance and operation of the navigation, to be contributed by the City is maintained as shown in the Interim Report pending completion of design and restudy of costs $880,000

d. Comparison with Project Document

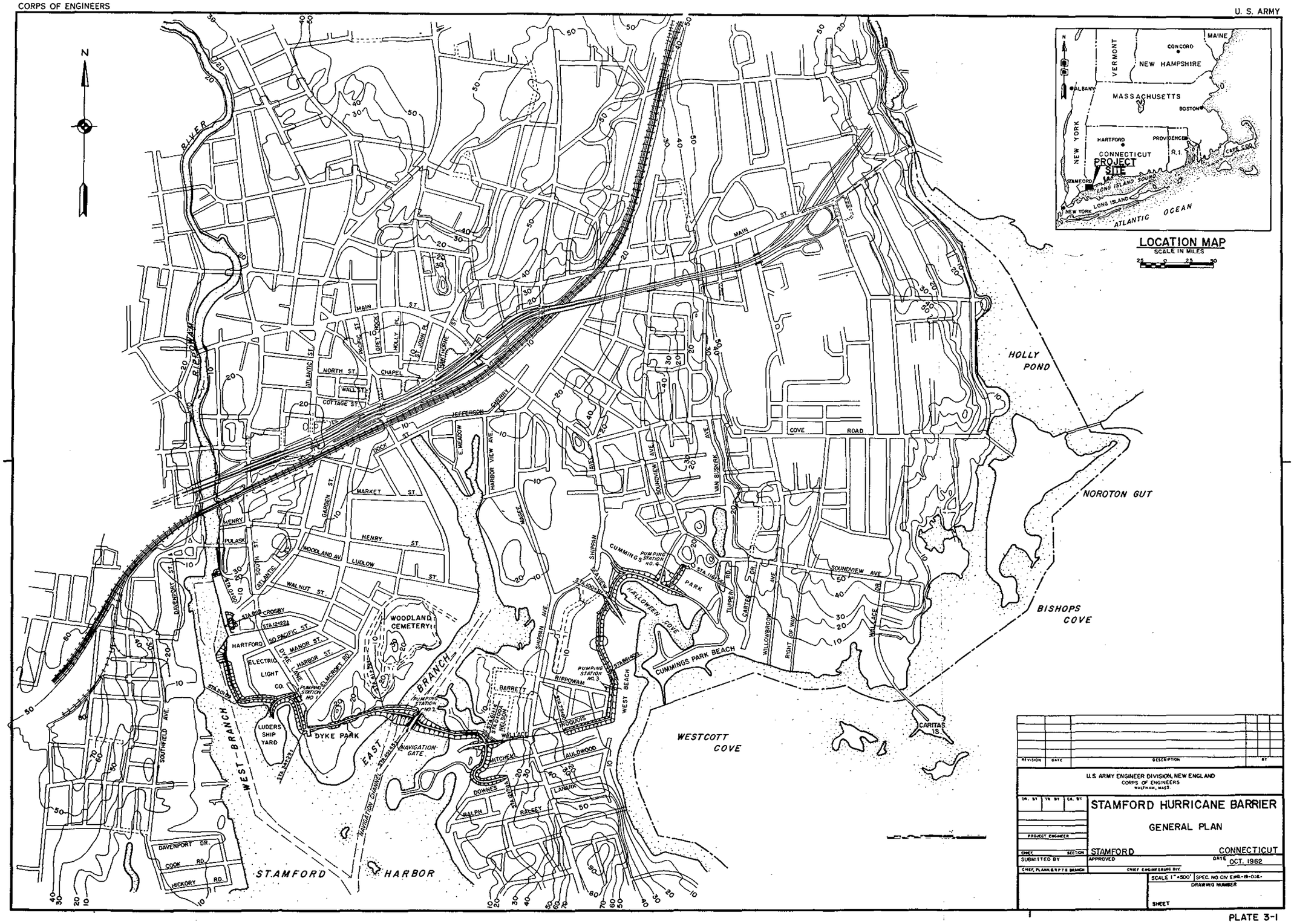
Annual Charges. - Interest and amortization charges are little different, increase in interest being about balanced by decrease in amortization due to change in effective life of the project to 100 years. Local maintenance and operation costs are increased because of added pumping stations.

R. RECOMMENDATION

49. Recommendation. - It is recommended that the project plan submitted in this report be approved as the basis for the preparation of contract plans.

CORPS OF ENGINEERS

U. S. ARMY



LOCATION MAP

SCALE IN MILES

25 0 25 50

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANS & SPTE BRANCH

STAMFORD HURRICANE BARRIER

GENERAL PLAN

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

CHIEF ENGINEERING DIV.

SCALE 1"=500' SPEC. NO CIV ENG-19-016-

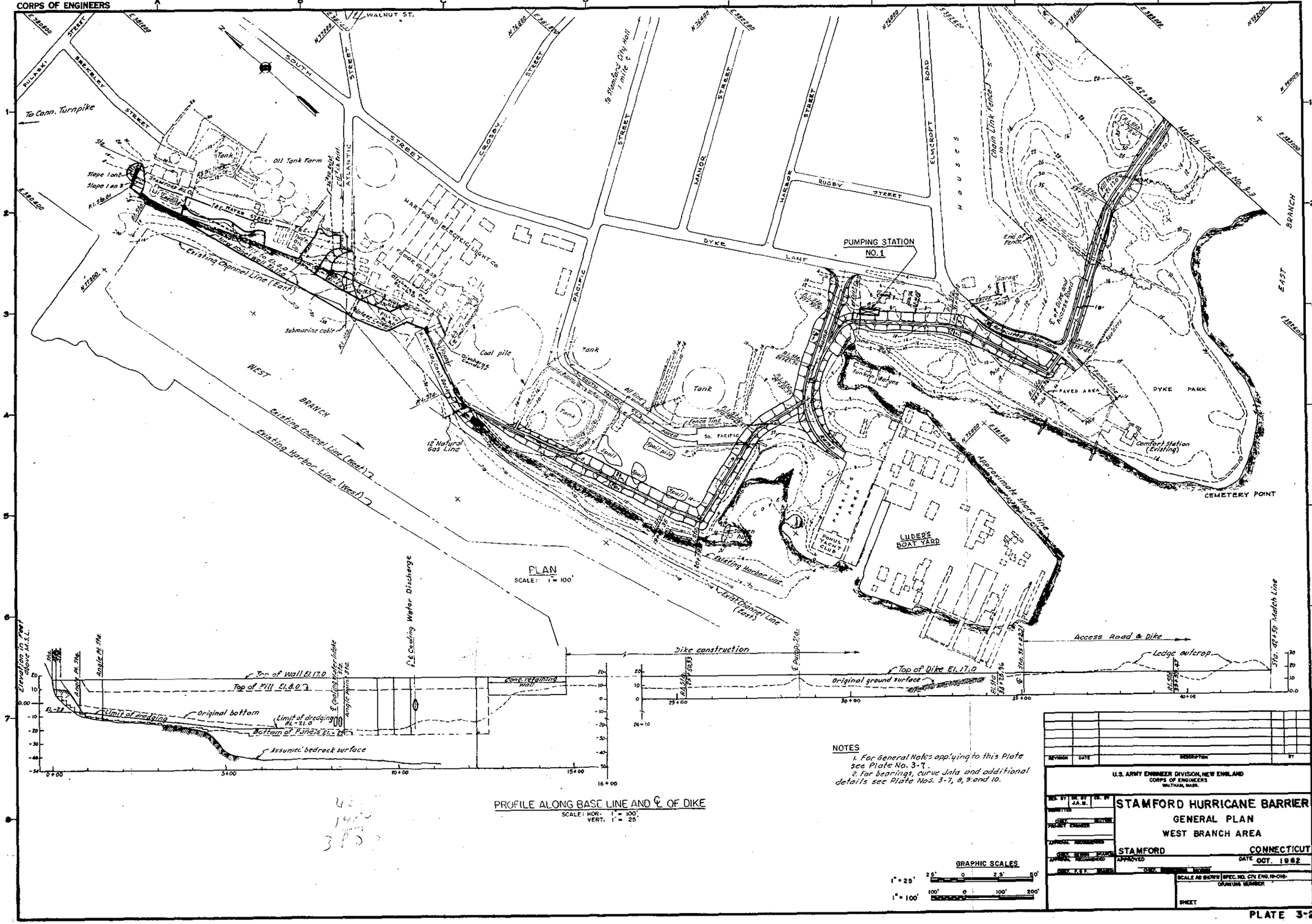
DRAWING NUMBER

SHEET

PLATE 3-1

CORPS OF ENGINEERS

U. S. ARMY



PLAN
SCALE: 1" = 100'

PROFILE ALONG BASE LINE AND ℄ OF DIKE
SCALE: HOR. 1" = 100'
VERT. 1" = 25'

NOTES

1. For General Notes applying to this Plate see Plate No. 3-9.
2. For bearings, curve data and additional details see Plate Nos. 3-7, 8, 9 and 10.

GRAPHIC SCALES

1" = 25' 25' 0 25' 50'

1" = 100' 100' 0 100' 200'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY J.A.M. | CK. BY

SUBMITTED

CHIEF, PROJECT ENGINEER | DATE

APPROVAL RECOMMENDED

CHIEF, ENGR. BRANCH | DATE

APPROVAL RECOMMENDED

CHIEF, E & P. BRANCH | DATE

STAMFORD HURRICANE BARRIER

GENERAL PLAN

WEST BRANCH AREA

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

DIVISION ENGINEER

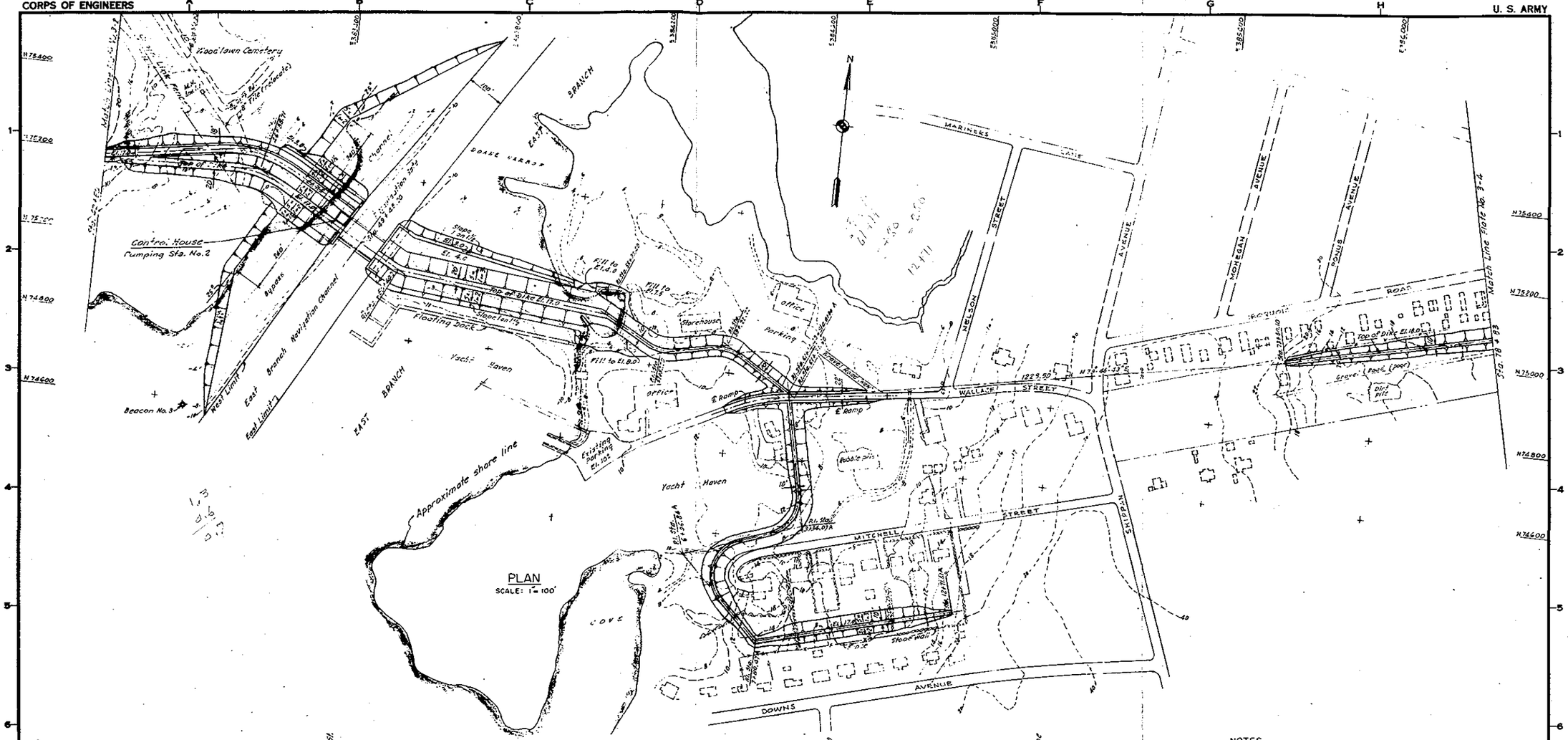
SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-010-

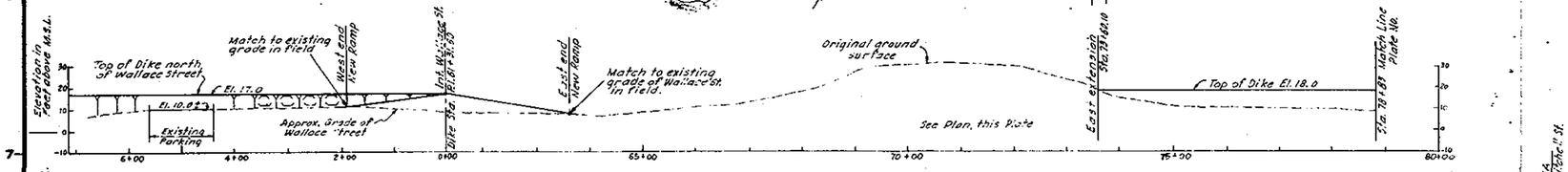
DRAWING NUMBER

SHEET

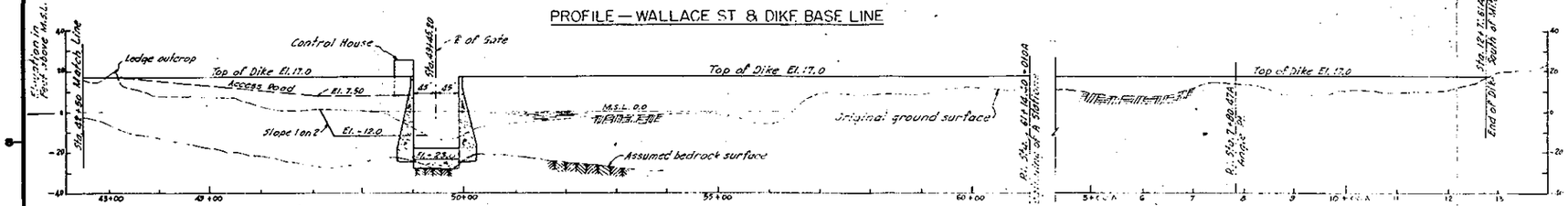
PLATE 3-2

CORPS OF ENGINEERS — U. S. ARMY





PROFILE — WALLACE ST & DIKE BASE LINE



PROFILE ALONG ℄ OF DIKE
SCALE HOR. 1" = 100'
VERT. 1" = 25'

NOTES

1. For General Notes applying to this Plate see Plate No. 3-7.
2. For bearings, curve data and additional details see Plate Nos. 3-11, 12 and 14.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY J.A.M. | CK. BY
SUBMITTED
CHIEF PROJECT ENGINEER SECTION
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, E & D BRANCH
CHIEF, ENGINEERING DIVISION

STAMFORD HURRICANE BARRIER
GENERAL PLAN
EAST BRANCH AREA

STAMFORD — CONNECTICUT
APPROVED — DATE SEP. 1966

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE 3-3

CORPS OF ENGINEERS

U. S. ARMY

SHIPPAN AVENUE

℄ of New Access Road to Pine Island Area

Trees and brush

Trees and brush

Existing dump area

Cummings Park

Match line Sta No. 3-3

Sta. 78+83.0

ALGONQUIN AVE.

PUMPING STATION NO. 3

WAMPANAW AVE.

SHIPPOWAM RD.

Existing parking to be abandoned

350 New Parking 140 Spaces

Existing walk

Wood Fence Thigh

MUZZIO BOAT YARD

Buildings

Existing Parking to be abandoned

IROQUOIS BEACH CLUB

Bath Houses (Wood)

WEST BEACH

Approximate shore line

HALLOWEEN COVE

WESTCOTT COVE

Existing Parking on Broken pavement

Cummings Park Boadway

Baseball

Football

Tennis

New walk

50 Spaces New Parking

PUMPING STATION NO. 4

Existing sidewalk

200' New Parking 80 Spaces

Trees

Park

Cummings

SOUND VIEW AVENUE

McMILLEN STREET

PLAN

SCALE: 1" = 100'

NOTES

1. For General Notes applying to this Plate see Plate No. 3-1
2. For bearings, curve data and additional details see Plate Nos. 3-14, 15, 16 and 17.

Elevation in feet above M.S.L.

Sta. 78+83.0 on Match Line

Sta. 79+00

El. 19.0

Top of Dike El. 19.0

℄ Pumping Station No. 3

Sta. 80+50

50' Transition

El. 18.0

Top of Dike El. 18.0

Original ground surface

Pl. Sta. 80+72.79

Pl. Sta. 87+42.91

Pl. Sta. 92+10.97

Sta. 92+00

Sta. 107+00

℄ Sanitary Station No. 4

Pond Drive Pump Str.

Pl. Sta. 111+22.15

Pl. Sta. 113+44.22

Sta. 117+63.15

End of Dike

80+00

85+00

90+00

110+00

115+00

116+00

PROFILE ON ℄ OF DIKE

SCALE: HOR. 1" = 100'
VERT. 1" = 25'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED

CHIEF, ENGINEERING DIVISION

PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED

CHIEF, P & O BRANCH

STAMFORD HURRICANE BARRIER

GENERAL PLAN

WESTCOTT COVE AREA

STAMFORD CONNECTICUT

APPROVED

DATE OCT. 1962

CHIEF, ENGINEERING DIVISION

SCALE 1" = 100' | SPEC. NO. CIV. ENG. 19-010-

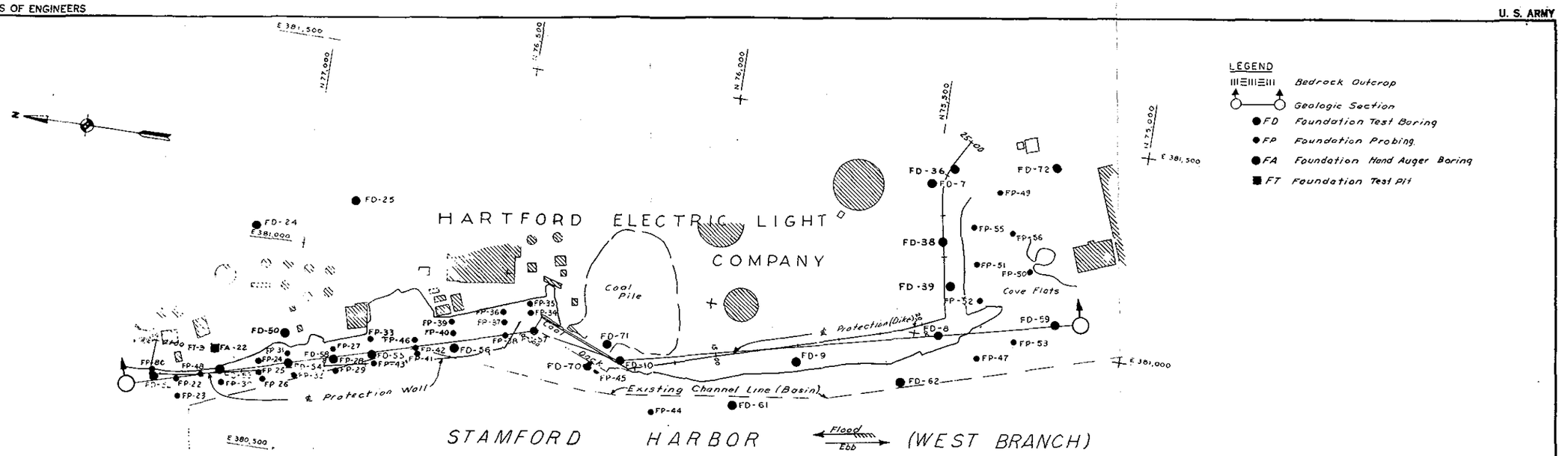
DRAWING NUMBER

SHEET

PLATE 3-4

CORPS OF ENGINEERS

U. S. ARMY

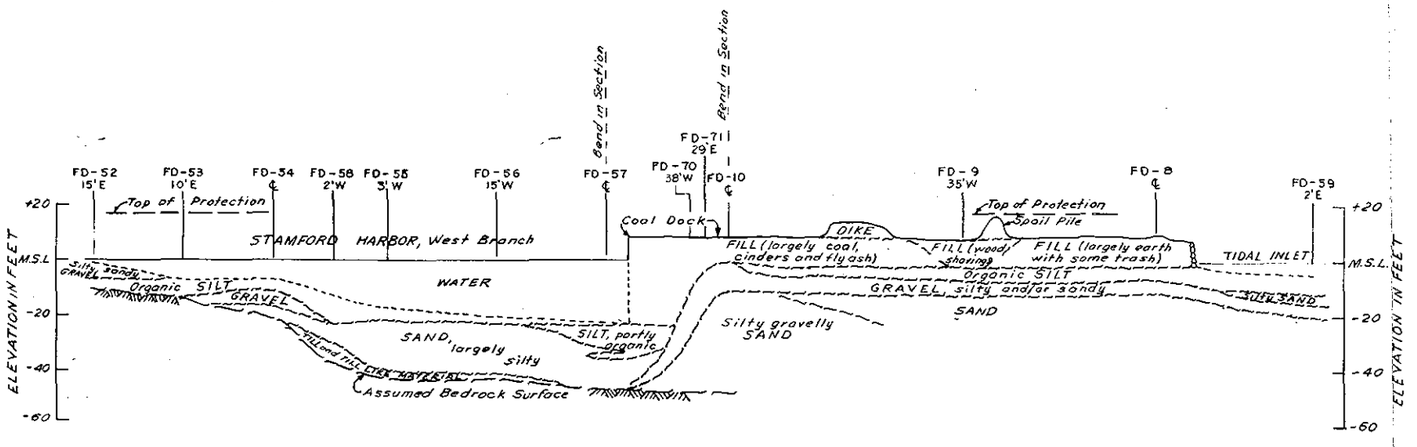


LEGEND

- Bedrock Outcrop
- Geologic Section
- FD Foundation Test Boring
- FP Foundation Probing
- FA Foundation Hand Auger Boring
- FT Foundation Test Pit

PLAN - STAMFORD HARBOR, WEST BRANCH

SCALE: 1" = 100'



GEOLOGIC SECTION - STAMFORD HARBOR, WEST BRANCH

(LOOKING EAST)
HORIZONTAL SCALE: 1" = 100'

GRAPHIC SCALE
100' 0 100' 200'
1" = 100'

NOTES

Coordinates refer to the Lambert Grid System for the State of Connecticut.
Elevations refer to Mean Sea Level

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY C.G.H.	DR. BY H.C.S.	CH. BY R.C.G.
SUBMITTED HEAD, GEOLOGY SECTION		
PROJECT ENGINEER		
APPROVAL RECOMMENDED CHIEF, FDN. & MAT'LS BRANCH		
APPROVAL RECOMMENDED CHIEF, PLANS & SPEC'S BRANCH		

STAMFORD HURRICANE BARRIER

PLAN OF EXPLORATIONS AND GEOLOGIC SECTION WEST BRANCH

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

CHIEF, ENGINEERING DIVISION

SCALE 1"=100' SPEC. NO CIV. ENG.-19-018-63-

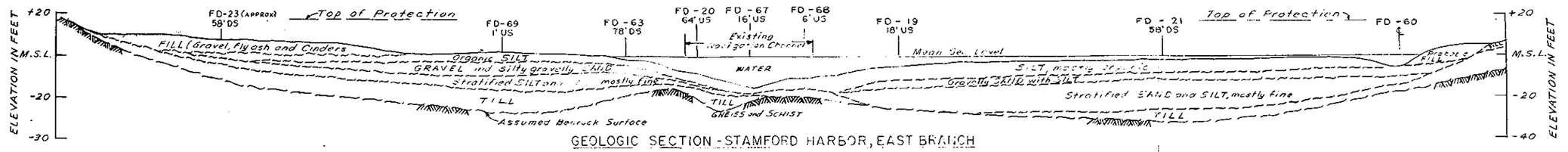
DRAWING NUMBER

SHEET

PLATE 3-5

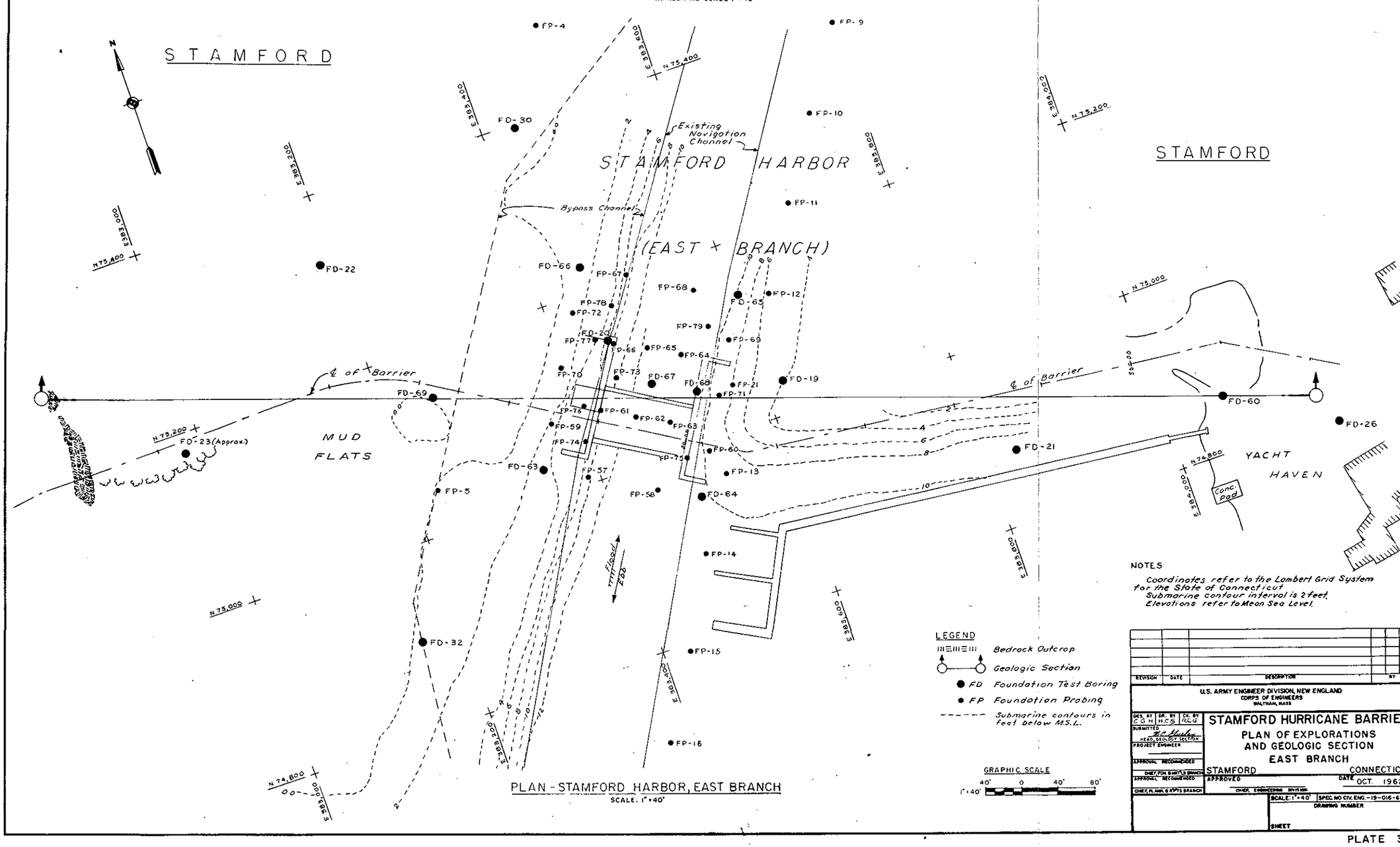
CORPS OF ENGINEERS

U. S. ARMY



GEOLOGIC SECTION - STAMFORD HARBOR, EAST BRANCH

(LOOKING NORTH)
HORIZONTAL SCALE 1"=40'



PLAN - STAMFORD HARBOR, EAST BRANCH

SCALE: 1"=40'

NOTES

Coordinates refer to the Lambert Grid System for the State of Connecticut.
Submarine contour interval is 2 feet.
Elevations refer to Mean Sea Level.

LEGEND

- Bedrock Outcrop
- Geologic Section
- FD Foundation Test Boring
- FP Foundation Probing
- Submarine contours in feet below M.S.L.

GRAPHIC SCALE

40' 0 40' 80'
1"=40'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CK. BY
C.G.H	H.C.S	R.C.G

SUBMITTED
H.C. Hudson
HEAD, GEOLOGY SECTION
PROJECT ENGINEER

APPROVAL RECOMMENDED
CHIEF, FDN. & SAN'Y. B'RANCH
APPROVAL RECOMMENDED
CHIEF, PLANS & APPTS BRANCH

STAMFORD HURRICANE BARRIER
PLAN OF EXPLORATIONS AND GEOLOGIC SECTION
EAST BRANCH

STAMFORD CONNECTICUT

APPROVED
DATE OCT. 1962
CHIEF, ENGINEERING DIVISION

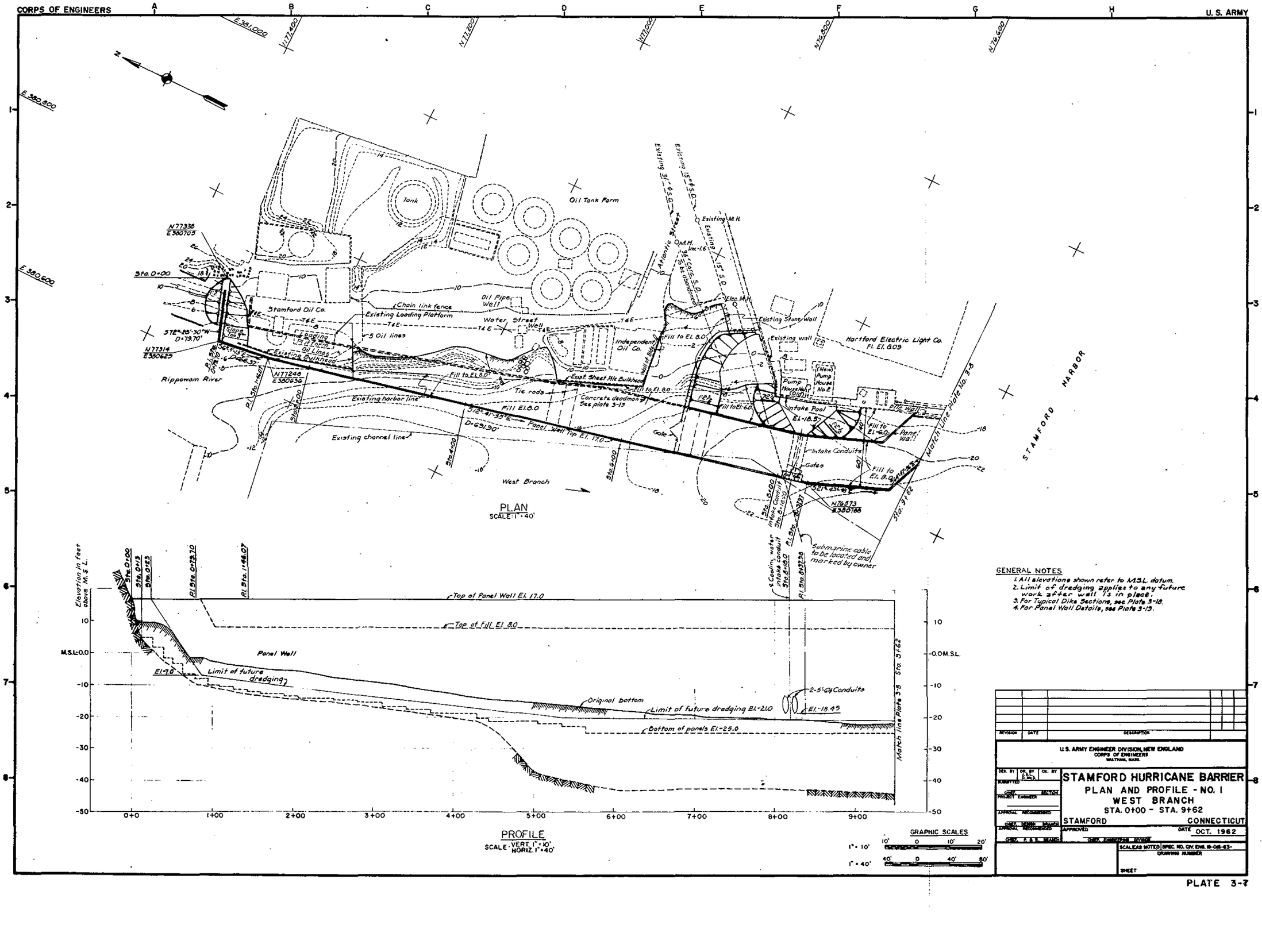
SCALE: 1"=40'
SPEC. NO CIV. ENG. -19-016-63-
DRAWING NUMBER

SHEET

PLATE 3-6

CORPS OF ENGINEERS

U.S. ARMY



GENERAL NOTES

1. All elevations shown refer to M.S.L. datum.
2. Limit of dredging applies to any future work after wall 13 in place.
3. For Typical Dike Sections, see Plate 3-18.
4. For Panel Wall Details, see Plate 3-13.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY P.S. & W.B. | CK. BY

SUBMITTED

CHIEF, PROJECT ENGINEER SECTION

APPROVAL RECOMMENDED

CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED

CHIEF, P. & S. BRANCH

STAMFORD HURRICANE BARRIER

PLAN AND PROFILE - NO. 1 WEST BRANCH

STA. 0+00 - STA. 9+62

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

CHIEF, ENGINEERING DIVISION

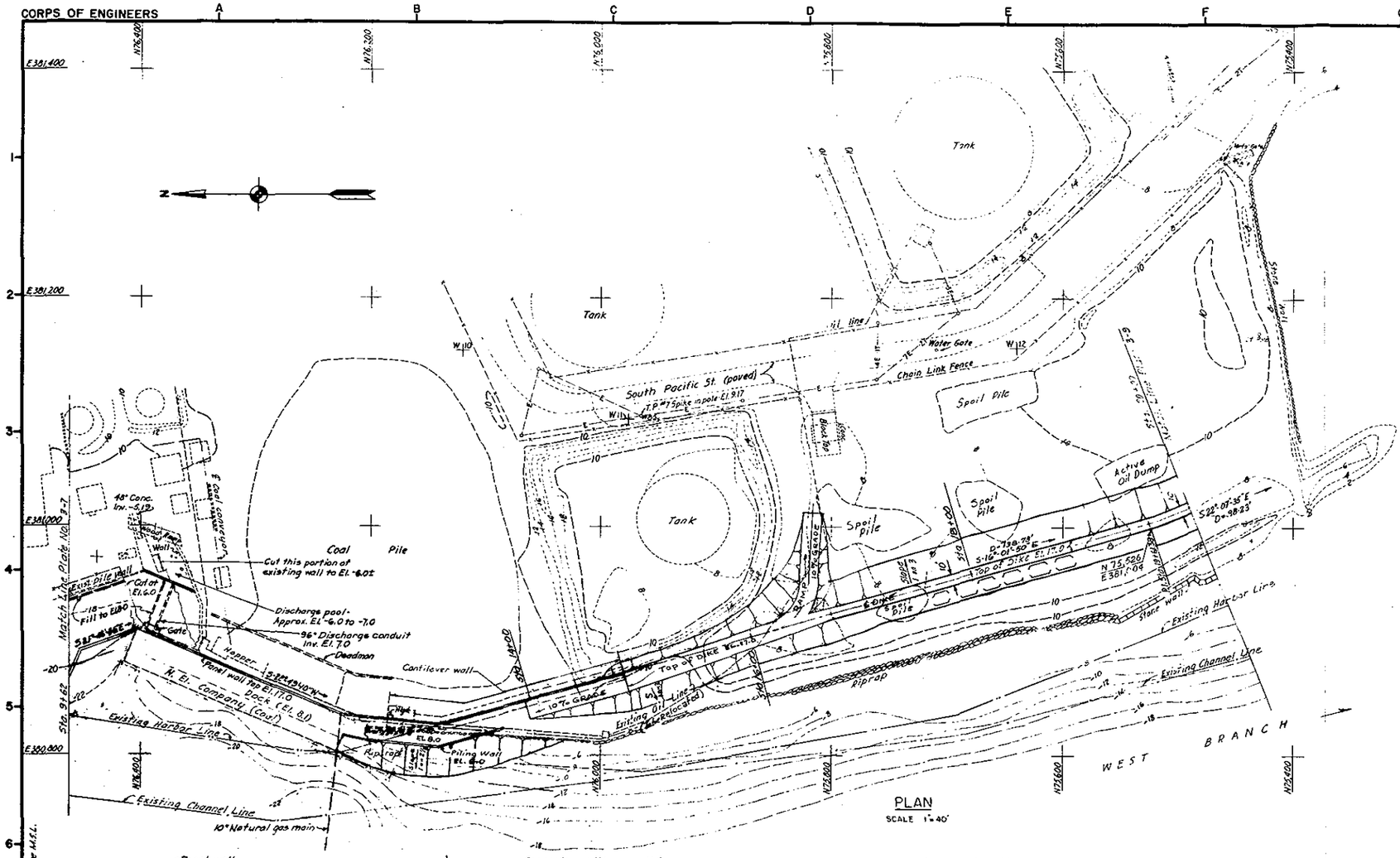
SCALE AS NOTED | SPEC. NO. CIV. ENG. 18-018-63-

DRAWING NUMBER

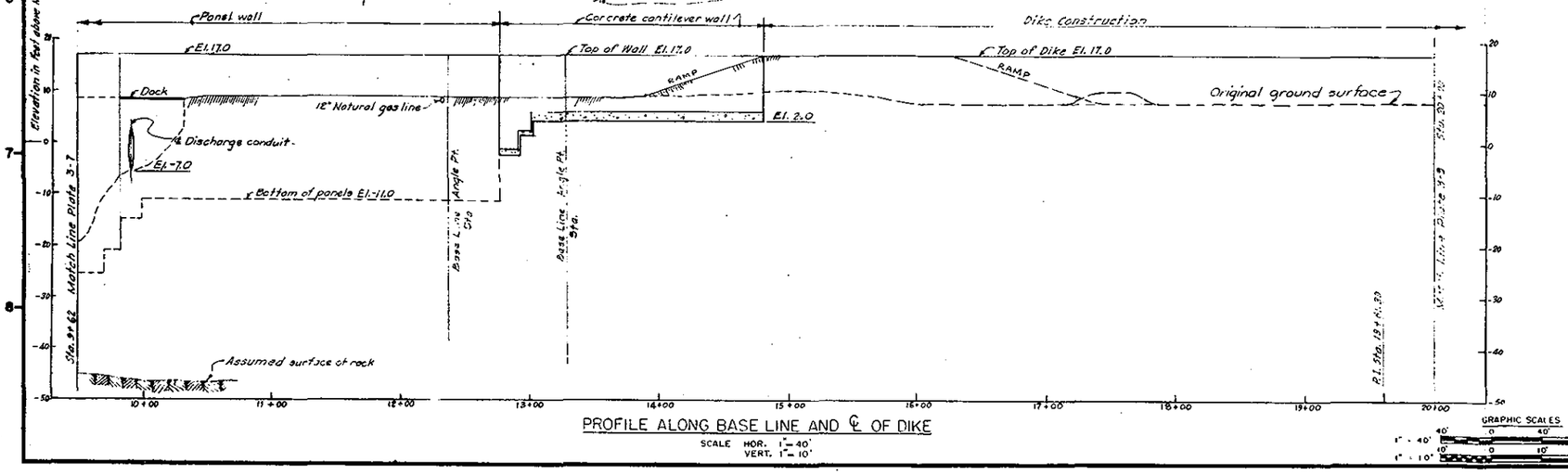
SHEET

PLATE 3-7

CORPS OF ENGINEERS — U.S. ARMY



PLAN
SCALE 1" = 40'



PROFILE ALONG BASE LINE AND ℄ OF DIKE
SCALE HOR. 1" = 40'
VERT. 1" = 10'

GRAPHIC SCALES
1" = 40'
1" = 10'

NOTE:
1. For General Notes, see Plate 3-7.
2. For Panel Wall details, see Plate 3-19.
3. For Coal Dock and Piling Wall details, see Plate 3-20.
4. For Pumping Station Details, see Plate 3-23.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

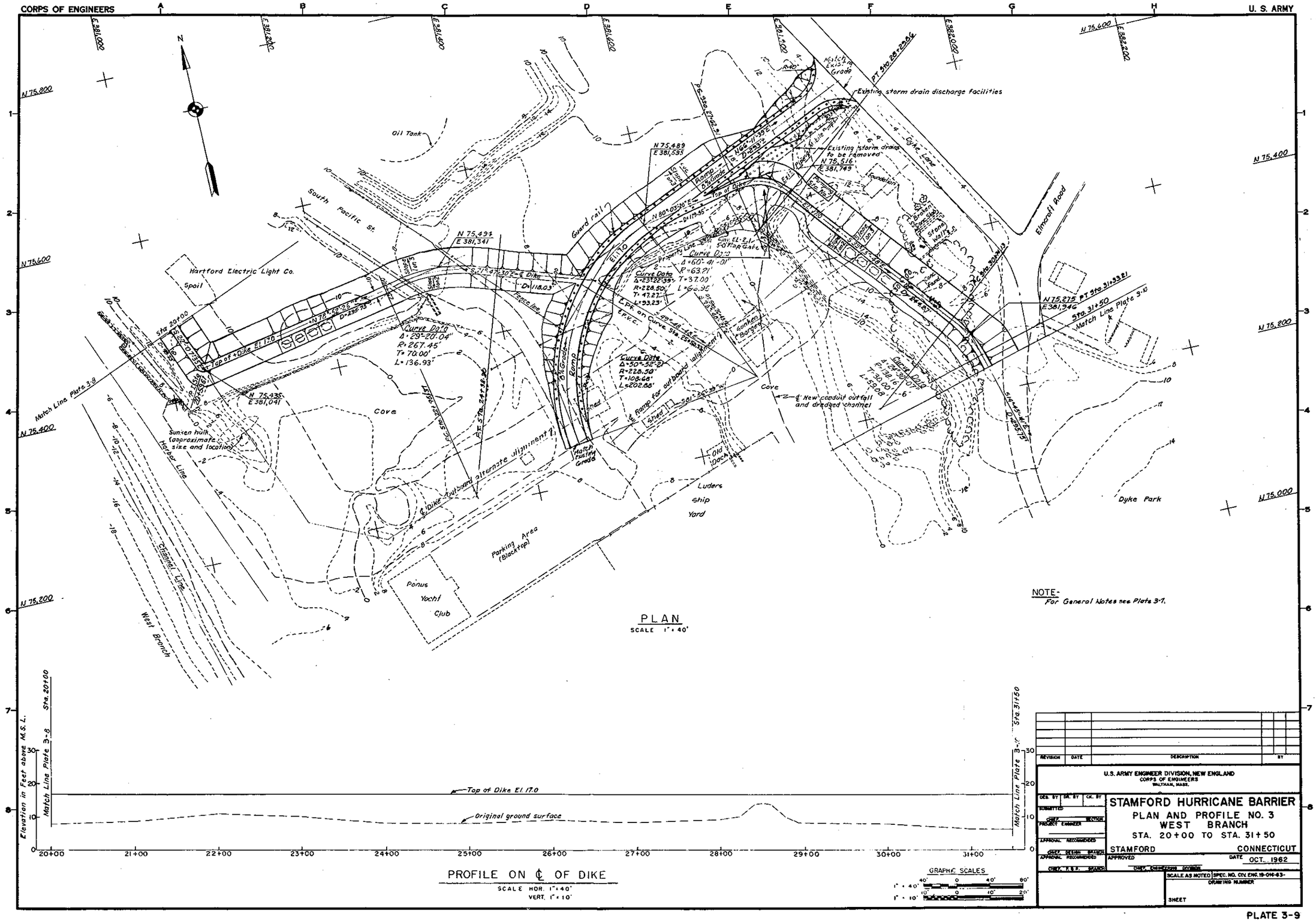
DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

STAMFORD HURRICANE BARRIER
PLAN AND PROFILE - NO. 2
WEST BRANCH
STA. 9+62 TO STA. 20+00
STAMFORD — CONNECTICUT
APPROVED — DATE OCT. 1962
CHIEF, ENGINEERING DIVISION

SCALE AS NOTED | SPEC. NO. CIV. ENG. 18-016-63-
DRAWING NUMBER
SHEET

PLATE 3-8

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE 1" = 40'

NOTE-
For General Notes see Plate 3-7.

PROFILE ON ℄ OF DIKE
SCALE HOR. 1" = 40'
VERT. 1" = 10'

GRAPHIC SCALES
1" = 40'
1" = 10'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, PROJECT ENGINEER SECTION
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, R.E.D. BRANCH
CHIEF, ENGINEERING DIVISION
APPROVED
DATE OCT. 1962

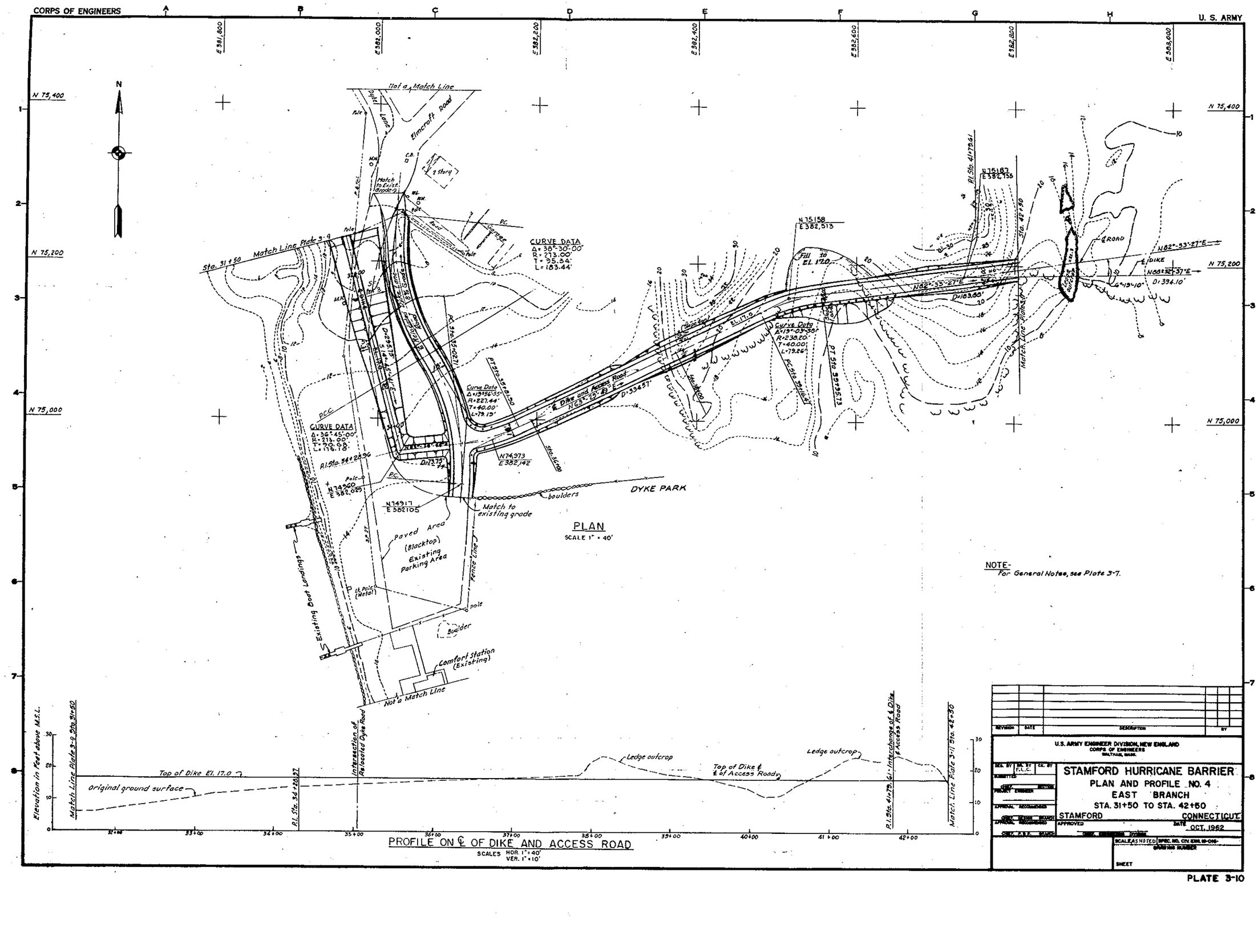
STAMFORD HURRICANE BARRIER
PLAN AND PROFILE NO. 3
WEST BRANCH
STA. 20+00 TO STA. 31+50

STAMFORD CONNECTICUT

SCALE AS NOTED | SPEC. NO. CIV. ENG. 19-016-63-
DRAWING NUMBER
SHEET

PLATE 3-9

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE 1" = 40'

NOTE-
For General Notes, see Plate 3-7.

PROFILE ON ℄ OF DIKE AND ACCESS ROAD
SCALES HOR. 1" = 40'
VER. 1" = 10'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
	F.C.C.	

SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, E & D BRANCH

STAMFORD HURRICANE BARRIER
PLAN AND PROFILE NO. 4
EAST BRANCH
STA. 31+50 TO STA. 42+50
STAMFORD CONNECTICUT

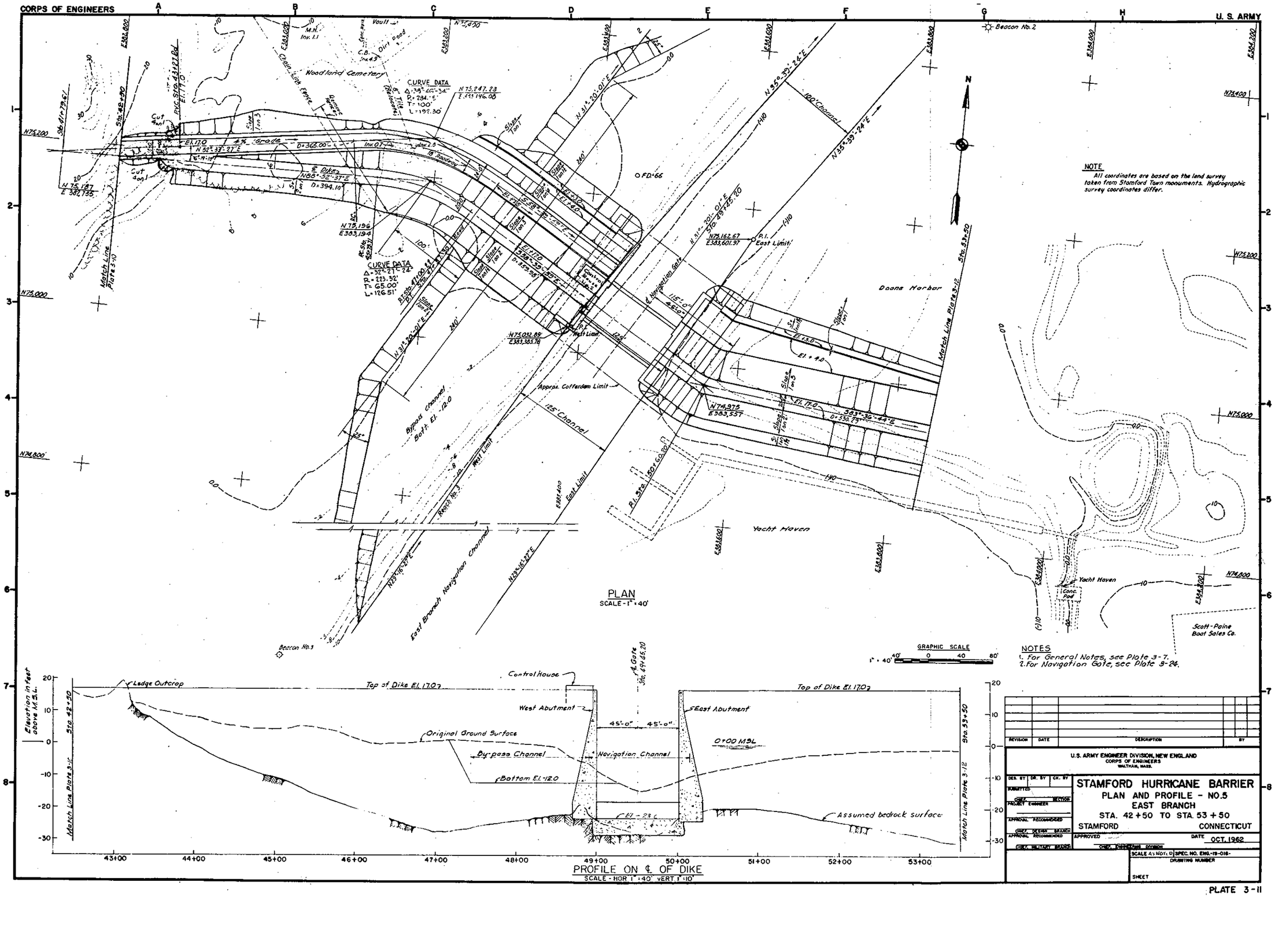
APPROVED
CHIEF, ENGINEERING DIVISION
DATE OCT. 1962

SCALE AS NOTED | SPEC. NO. CIV. ENG. 19-ONE-
DRAWING NUMBER
SHEET

PLATE 3-10

CORPS OF ENGINEERS

U. S. ARMY



PLAN
SCALE - 1" = 40'

GRAPHIC SCALE
1" = 40' 40' 0 40 80'

NOTES
1. For General Notes, see Plate 3-7.
2. For Navigation Gate, see Plate 3-24.

PROFILE ON ℄ OF DIKE
SCALE - HOR 1" = 40' VERT 1" = 10'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF SECTION
PROJECT ENGINEER

APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED
CHIEF, MILITARY BRANCH

STAMFORD HURRICANE BARRIER
PLAN AND PROFILE - NO.5
EAST BRANCH
STA. 42+50 TO STA. 53+50

STAMFORD CONNECTICUT

APPROVED
CHIEF, ENGINEERING DIVISION

DATE OCT. 1962

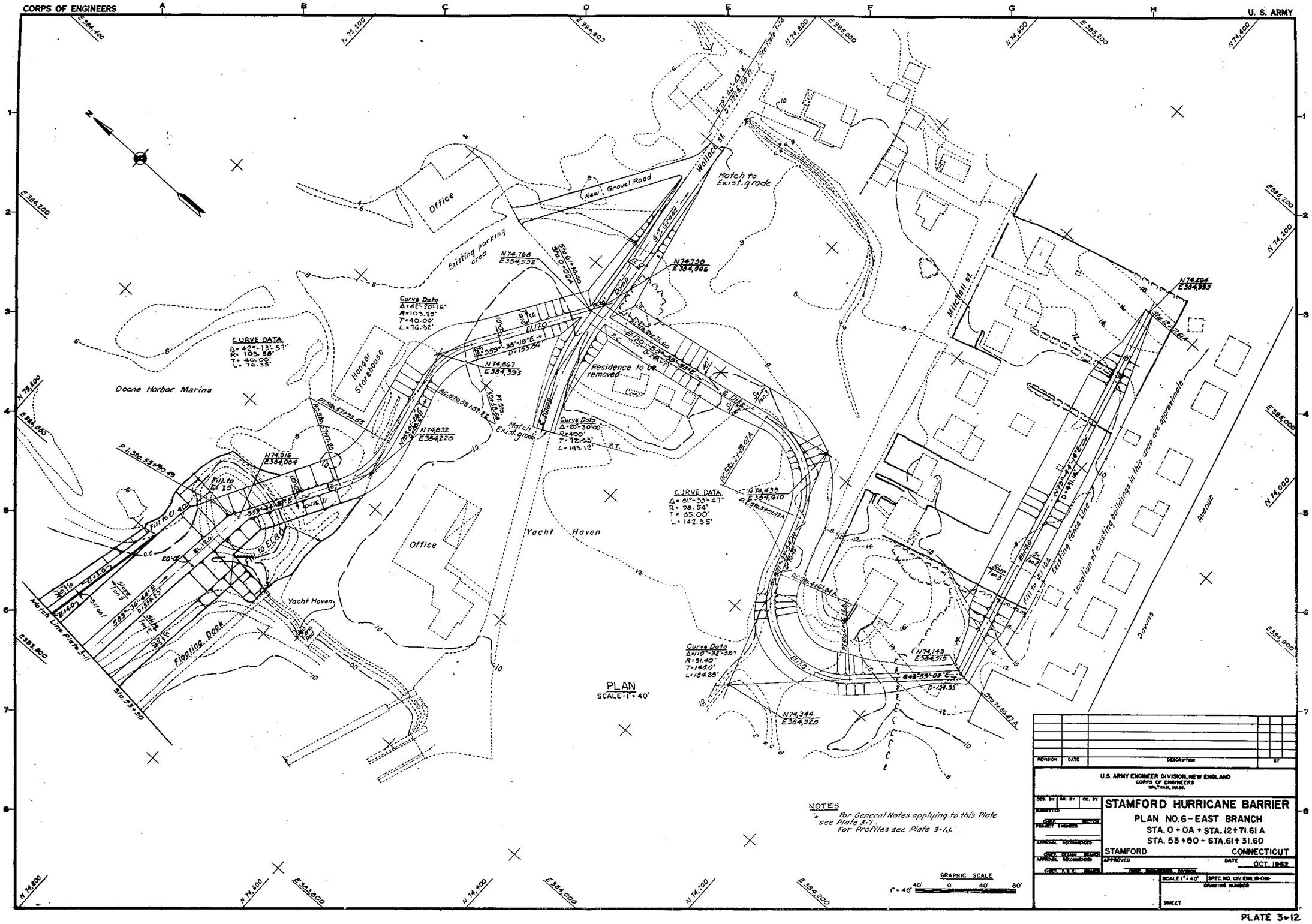
SCALE AS NOT. D | SPEC. NO. ENG-19-016-
DRAWING NUMBER

SHEET

PLATE 3-11

CORPS OF ENGINEERS

U. S. ARMY



NOTES

For General Notes applying to this Plate see Plate 3-1.
For Profiles see Plate 3-13.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED

CHIEF SECTION

PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED

CHIEF, E & D BRANCH

STAMFORD HURRICANE BARRIER

PLAN NO. 6 - EAST BRANCH

STA. 0 + 0A + STA. 12 + 71.61 A
STA. 53 + 60 - STA. 61 + 31.60

STAMFORD CONNECTICUT

APPROVED

DATE OCT. 1962

CHIEF, ENGINEERING DIVISION

SCALE 1" = 40'

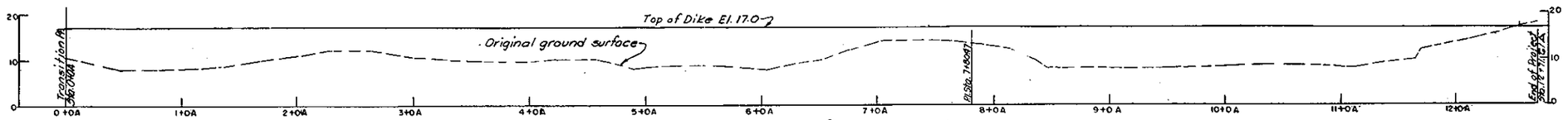
SPEC. NO. CIV ENG 19-016-

DRAWING NUMBER

SHEET

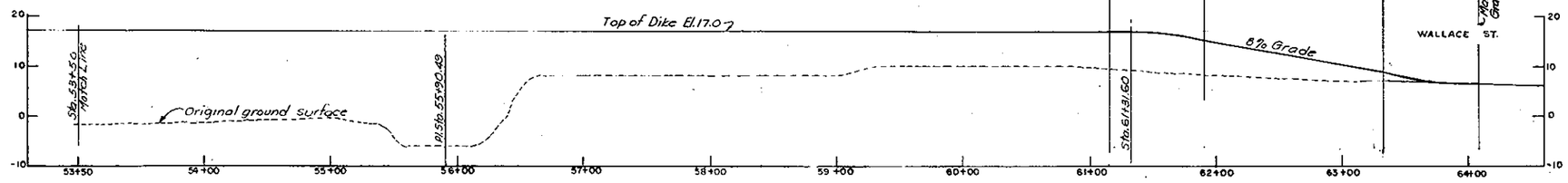
PLATE 3-12

CORPS OF ENGINEERS



PROFILE ALONG ℄ OF DIKE

SCALES HOR. 1" = 40'
VER. 1" = 10'



PROFILE ALONG ℄ OF DIKE AND WALLACE STREET

SCALES HOR. 1" = 40'
VER. 1" = 10'

NOTE
For Location of profiles, see Plate 3-12.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY A.J.M. | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, E. & D. BRANCH

STAMFORD HURRICANE BARRIER

PROFILES NO.6-EAST BRANCH
STA. 0+0A TO STA. 12+71.61A
STA. 53+50 TO STA. 61+31.60

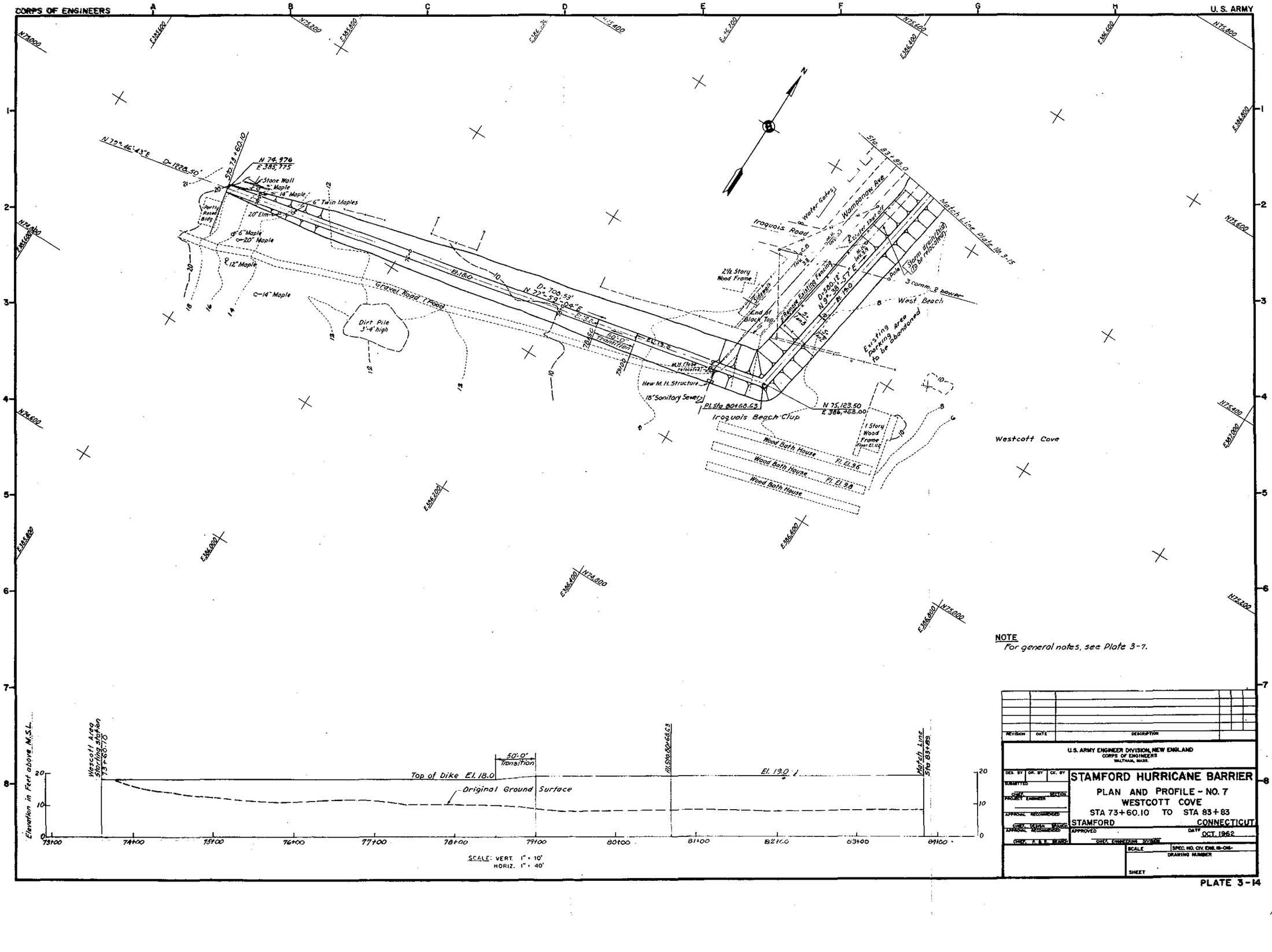
STAMFORD CONNECTICUT

APPROVED
DATE OCT. 1962
CHIEF, ENGINEERING DIVISION

SCALE AS NOTED SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE 3-13

CORPS OF ENGINEERS — U. S. ARMY



SCALE: VERT. 1" = 10'
HORIZ. 1" = 40'

NOTE
For general notes, see Plate 3-7.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF, PROJECT ENGINEER SECTION
APPROVAL RECOMMENDED
CHIEF, CONSTR. SECTION
APPROVAL RECOMMENDED
CHIEF, E. & D. BRANCH

STAMFORD HURRICANE BARRIER

PLAN AND PROFILE - NO. 7
WESTCOTT COVE
STA 73+60.10 TO STA 83+83

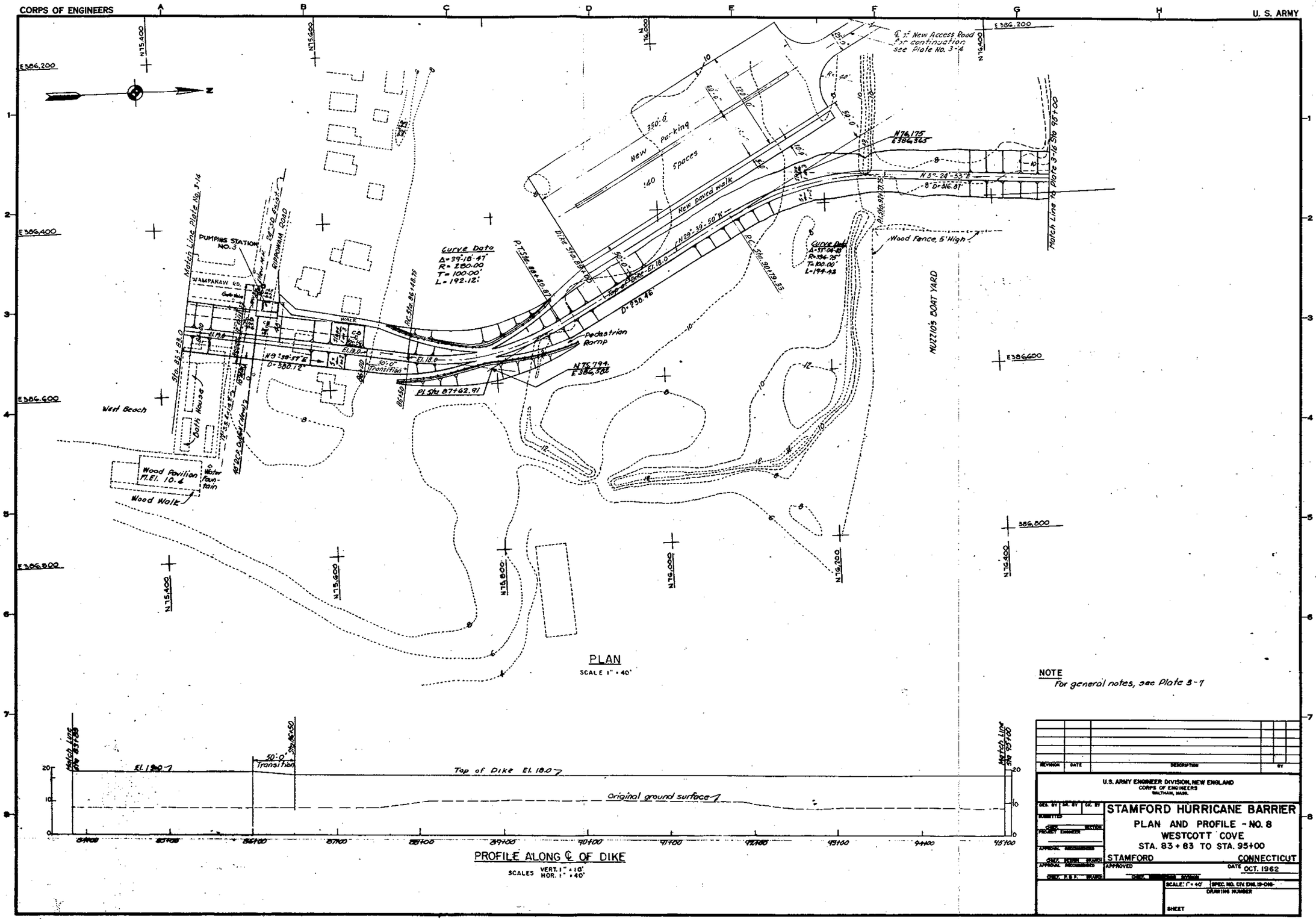
STAMFORD CONNECTICUT

APPROVED
DATE OCT. 1962
CHIEF, ENGINEERING DIVISION

SCALE
SPEC. NO. CIV. ENG. 19-ONE-
DRAWING NUMBER
SHEET

PLATE 3-14

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE 1" = 40'

PROFILE ALONG ℄ OF DIKE
SCALES VERT. 1" = 10'
HOR. 1" = 40'

NOTE
For general notes, see Plate 3-1

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, ENGINEERING DIVISION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, PLANS BRANCH
APPROVAL RECOMMENDED
CHIEF, R.E.D. BRANCH

STAMFORD HURRICANE BARRIER
PLAN AND PROFILE - NO. 8
WESTCOTT COVE
STA. 83+83 TO STA. 95+00

STAMFORD — CONNECTICUT

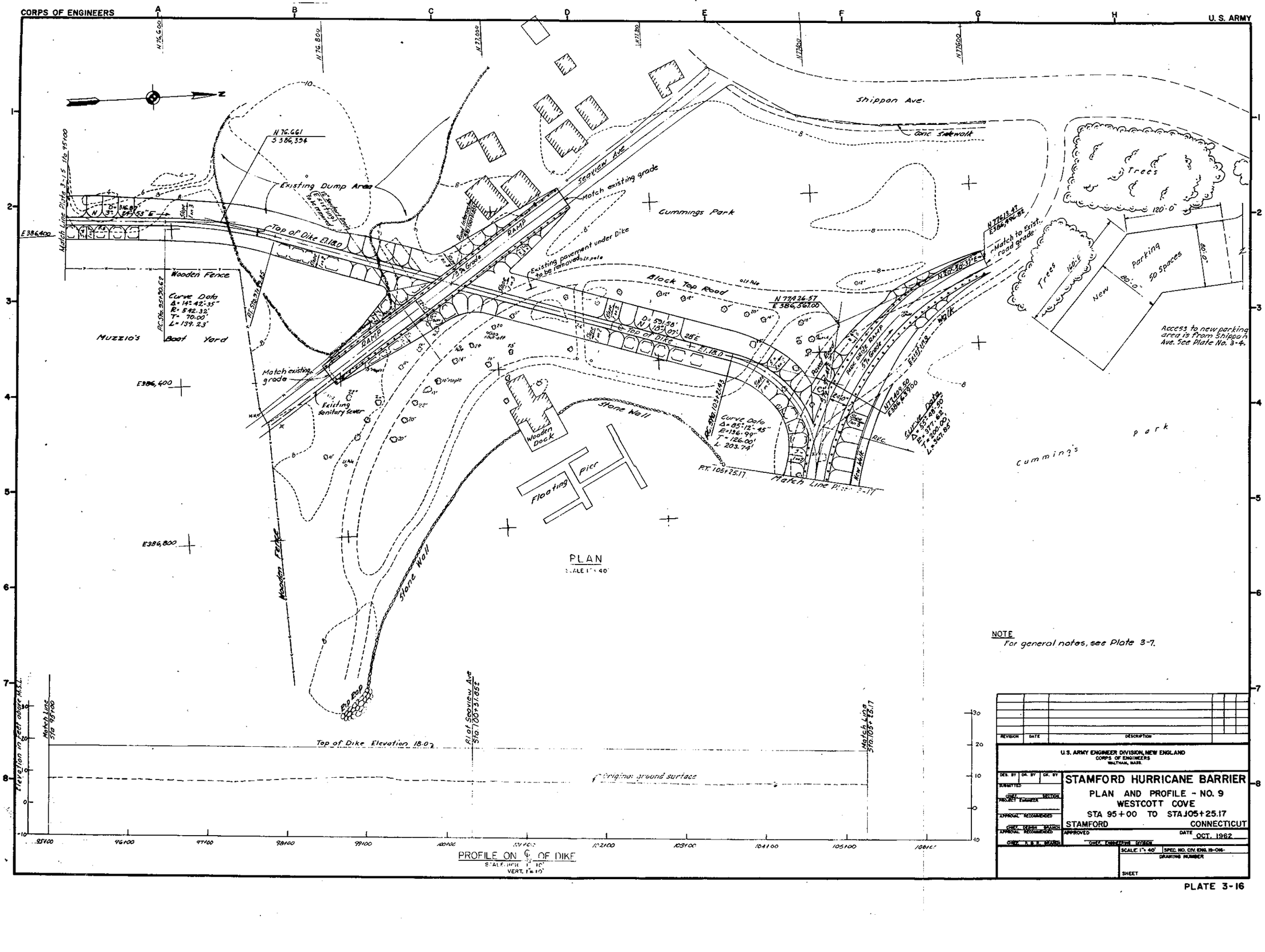
APPROVED
CHIEF, ENGINEERING DIVISION
DATE OCT. 1962

SCALE: 1" = 40' | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE 3-15

CORPS OF ENGINEERS

U.S. ARMY



NOTE

For general notes, see Plate 3-7.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CH. BY

SUBMITTED
CHIEF, PROJECT ENGINEER DIVISION

APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED
CHIEF, R. & R. BRANCH

STAMFORD HURRICANE BARRIER

PLAN AND PROFILE - NO. 9
WESTCOTT COVE
STA 95+00 TO STA 105+25.17
STAMFORD CONNECTICUT

APPROVED
CHIEF, ENGINEERING DIVISION

DATE OCT. 1962

SCALE 1" = 40'

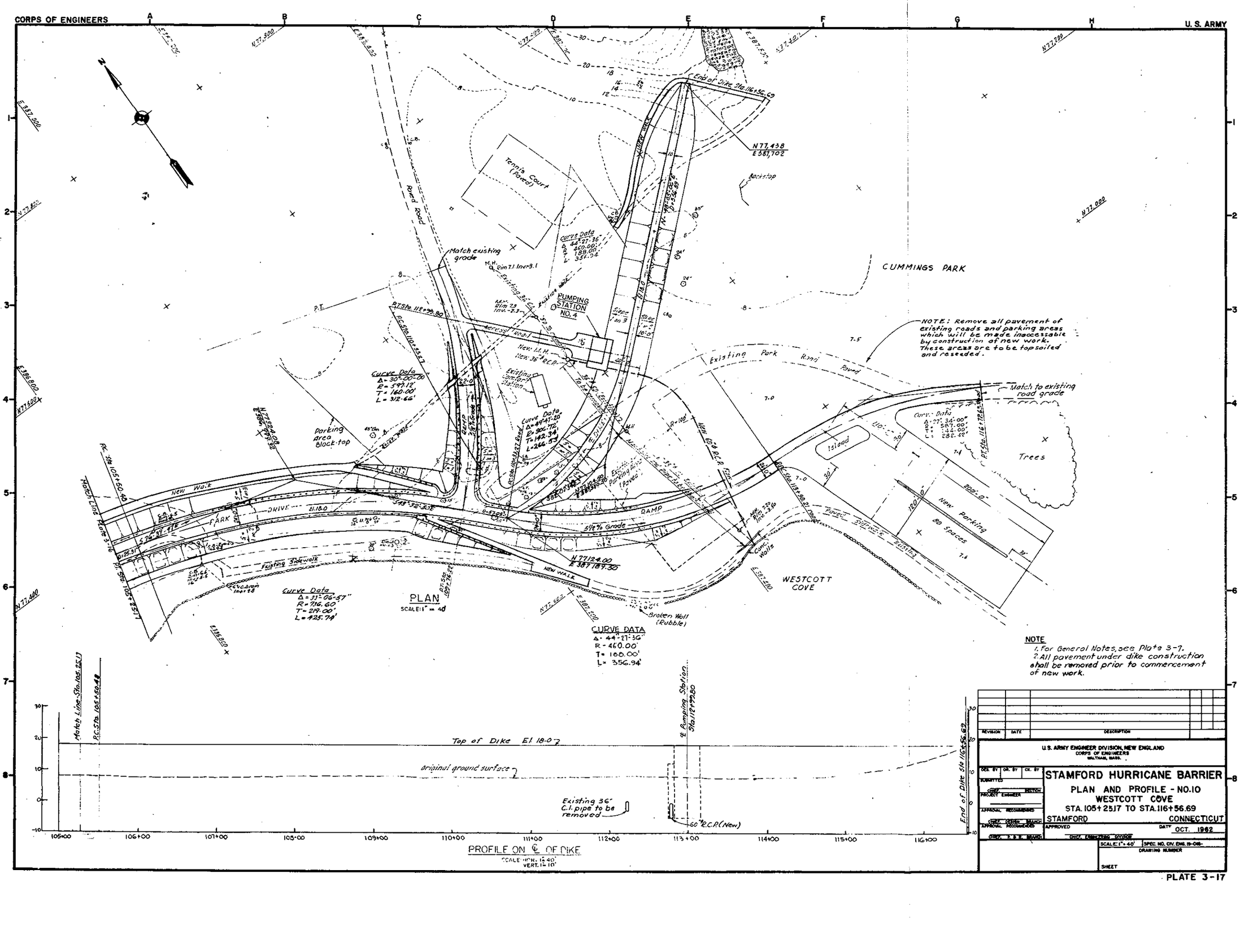
SPEC. NO. CIV. ENG. 19-016-

DRAWING NUMBER

SHEET

PLATE 3-16

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE: 1" = 40'

PROFILE ON ℄ OF DIKE
SCALE: HOR. 1" = 40'
VERT. 1" = 10'

NOTE
1. For General Notes, see Plate 3-7.
2. All pavement under dike construction shall be removed prior to commencement of new work.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

STAMFORD HURRICANE BARRIER

PLAN AND PROFILE - NO. 10
WESTCOTT COVE
STA. 105+25.17 TO STA. 116+56.69

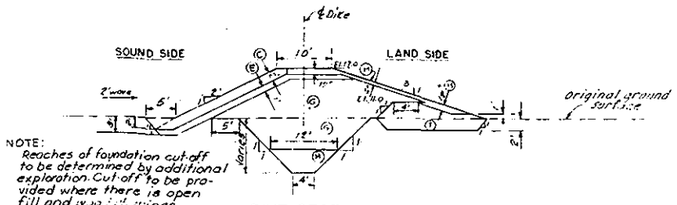
STAMFORD — CONNECTICUT

APPROVED — DATE OCT. 1962
CHIEF, ENGINEERING DIVISION

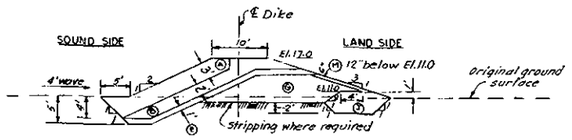
SCALE: 1" = 40' | SPEC. NO. CIV. ENG. 19-065
DRAWING NUMBER
SHEET

PLATE 3-17

CORPS OF ENGINEERS — U. S. ARMY



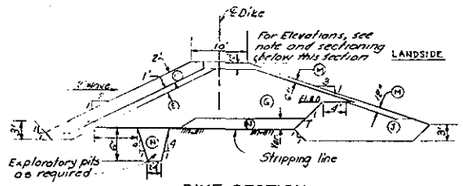
DIKE SECTION
(STA. 14+80 TO STA. 20+58)
SCALE 1" = 10'



DIKE SECTION
STA 20+58 TO STA. 25+00
STA 28+00 TO STA. 34+90
STA. 25+00 TO STA. 28+00

Sta. 25+00 to Sta. 28+00 is similar except as widened to accommodate pump.

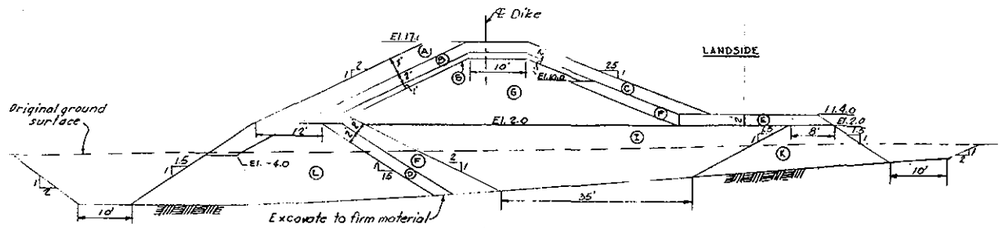
SCALE 1" = 10'



DIKE SECTION

Top of dike from Sta. 55+50 to Sta. 61+10 to be at Elev. 17.0.
Top of dike from Sta. 0100A to Sta. 124+71 to be at Elev. 17.0.
Top of dike from Sta. 131+60 to Sta. 138+50 to be at Elev. 18.0.
Sta. 78+50 to Sta. 86+00 to be Elev. 19.0 and Sta. 86+50 to Sta. 116+56.69 to be at Elev. 18.0.
This Section is Typical except along Park Drive where it shall be widened to accommodate road width.

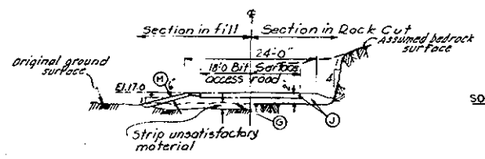
Between Sta. 79+00 and Sta. 86+00 Dike shall be constructed one (1) additional foot in height (Elevation 19.0) to compensate for anticipated settlement of approximately one (1) foot. Provide cut-off trench in old clamp Sta. 74+00 to Sta. 78+00.



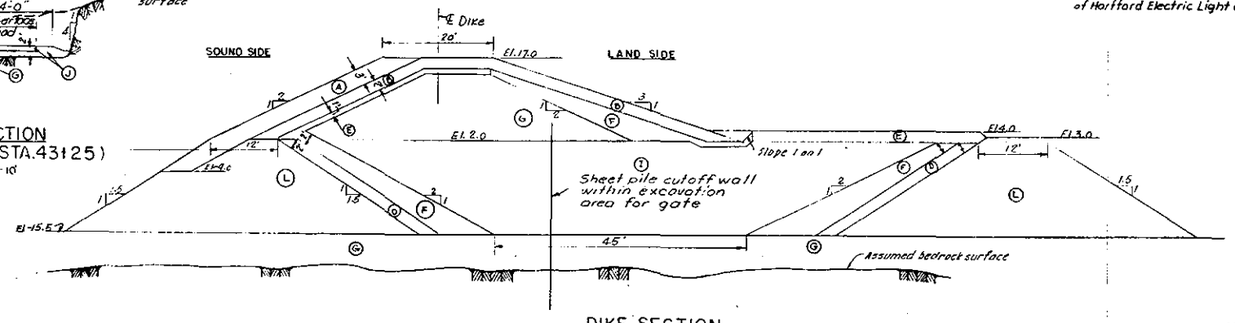
DIKE SECTION
OUTBOARD ALIGNMENT-STA 21+00A TO STA. 30+00A
Details of Dike toes vary according to exposure to wave action and to topography.

SCALE 1" = 10'

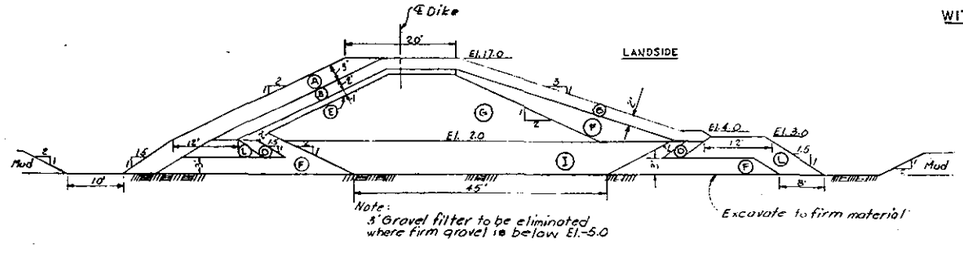
NOTE:
Outboard alignment is alternate for maximum future development of Hartford Electric Light Co. area.



DIKE SECTION
(STA. 34+90 TO STA. 43+25)
SCALE 1" = 10'



DIKE SECTION
WITHIN LIMITS OF COFFERDAM
SCALE 1" = 10'



DIKE SECTION
(STA. 43+25 TO STA. 55+50)
(EXCEPT WITHIN COFFERDAM LIMITS)
SEE SECTION THIS PLATE
SCALE 1"=10'

LEGEND

- (A) Cover Stone (450 to 7001 lbs.
- (B) Bedding Stone (2" to 801 lbs.)
- (C) Stone Slope Protection
- (D) Rock Filter
- (E) Gravel Bedding
- (F) Gravel Filter
- (G) Compacted Impervious Fill
- (H) Uncompacted Impervious Fill
- (I) Dumped Impervious Fill
- (J) Compacted Gravel Fill
- (K) Dumped Gravel Fill
- (L) Rock Fill
- (M) Topsoil & Seed
- (N) Waste Fill

NOTES

For general notes applying to this Plate see Plate No. 3-7
The stationing of Dike Sections is approximate.

GRAPHIC SCALE
1" = 10'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY A.J.F.H. | CK. BY

STAMFORD HURRICANE BARRIER

TYPICAL DIKE SECTIONS

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

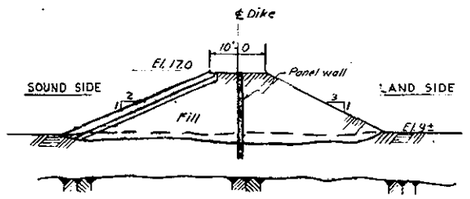
SCALE: 1" = 10' | SPEC. NO. CIV. ENG. 19-016-

DRAWING NUMBER

SHEET

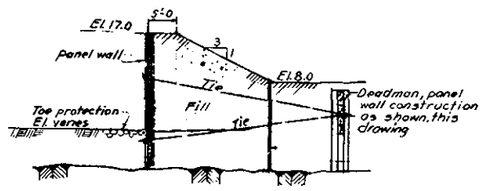
PLATE 3-16

CORPS OF ENGINEERS — U. S. ARMY



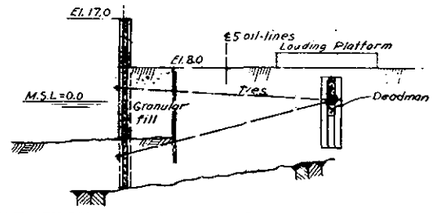
SECTION - STA. 0 + 20

SCALE: 1" = 10'



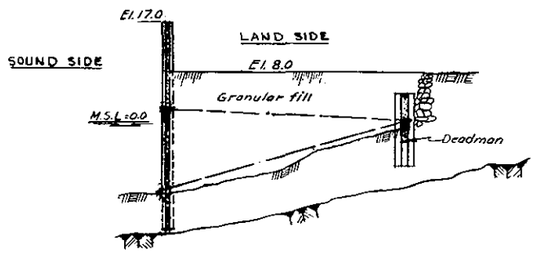
SECTION - STA. 0 + 70

SCALE: 1" = 10'



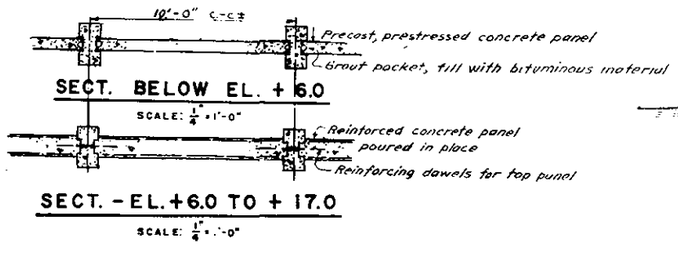
SECTION - STA. 2 + 00

SCALE: 1" = 10'



SECTION - STA. 4 + 00

SCALE: 1" = 10'

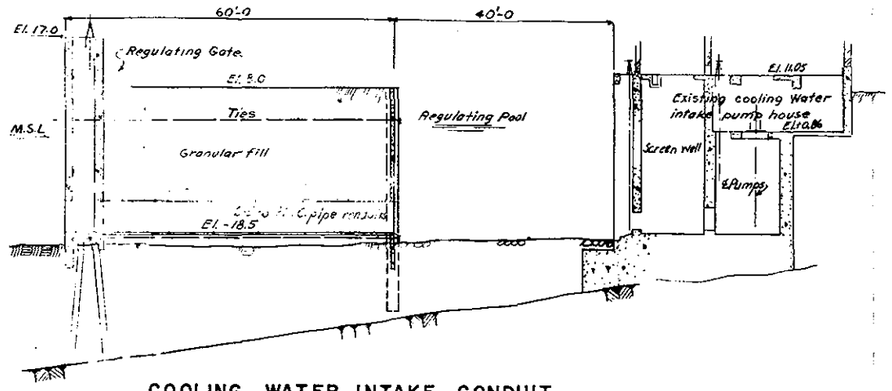


SECT. BELOW EL. + 6.0

SCALE: 1/4" = 1'-0"

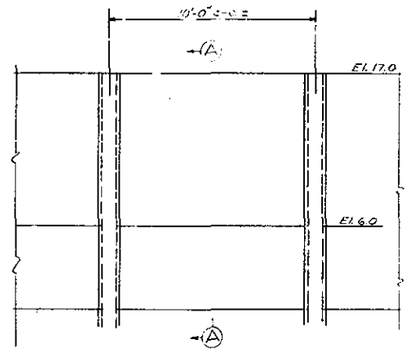
SECT. - EL. +6.0 TO + 17.0

SCALE: 1/4" = 1'-0"



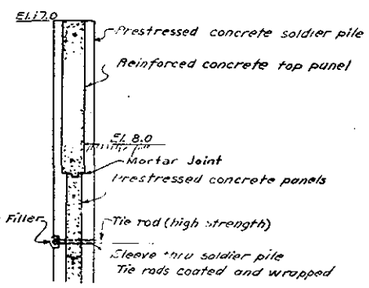
COOLING WATER INTAKE CONDUIT

SCALE: 1" = 10'



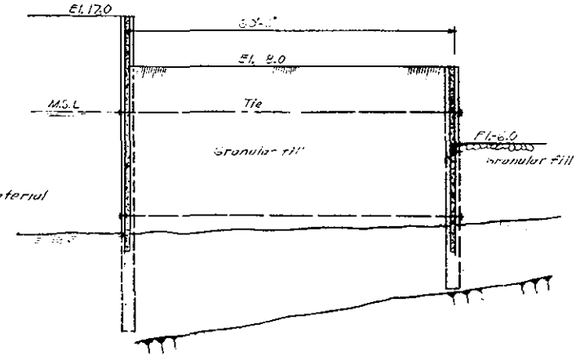
PANEL WALL - TYPICAL DETAILS

SCALE: 1/4" = 1'-0"



SECTION A-A

SCALE: 1/4" = 1'-0"



SECTION - STA. 7 + 25

SCALE: 1" = 10'

GRAPHIC SCALES

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, RELIANT BRANCH

STAMFORD HURRICANE BARRIER

PANEL WALL - STA. 0+00 - STA. 10+24±

TYPICAL SECTIONS

STAMFORD — CONNECTICUT

APPROVED — DATE OCT. 1962

CHIEF, ENGINEERING DIVISION

SCALE

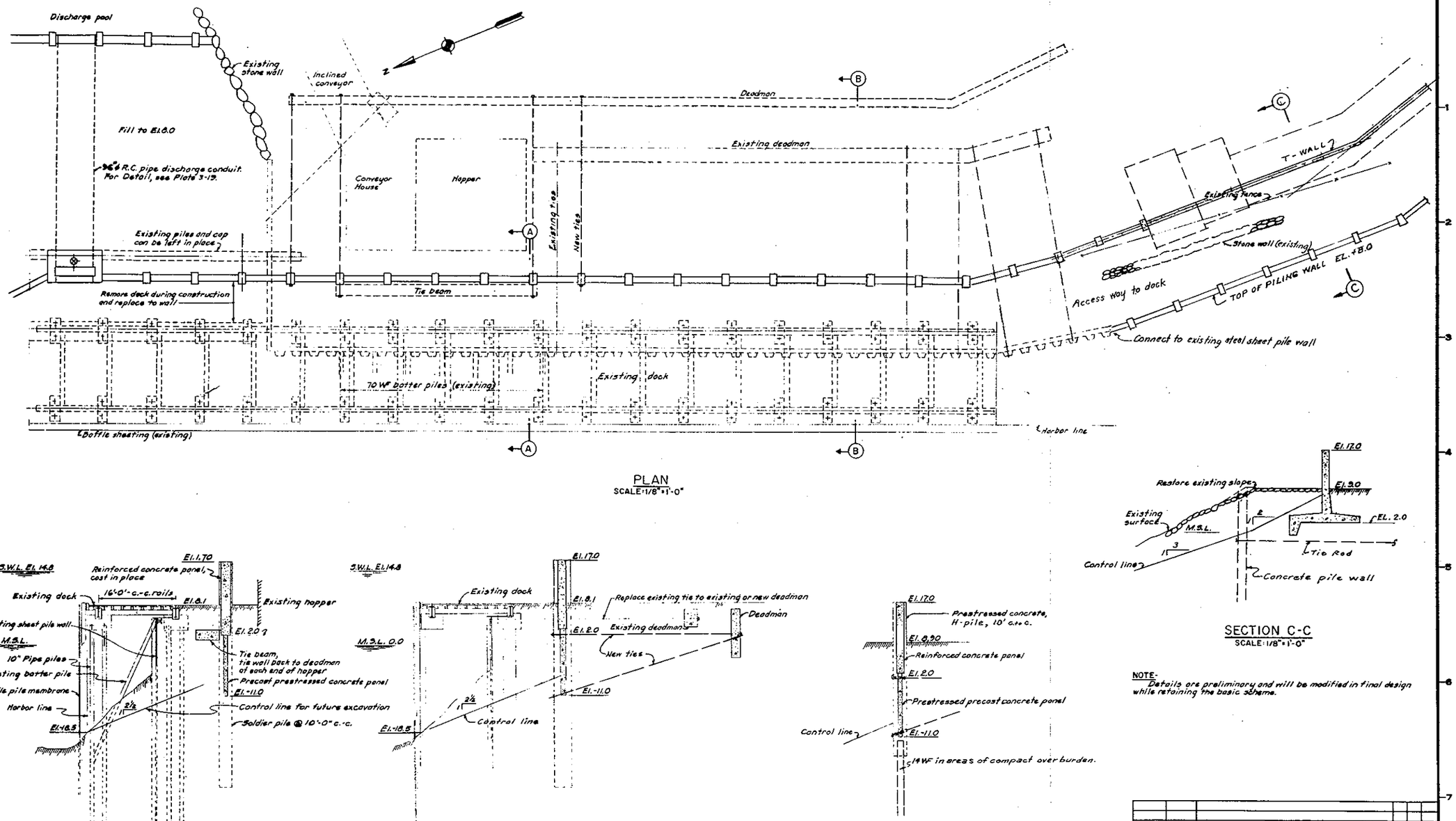
SPEC. NO. CIV. ENG. 19-016-63-

DRAWING NUMBER

SHEET

PLATE 3-19

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE: 1/8" = 1'-0"

SECTION C-C
SCALE: 1/8" = 1'-0"

SECTION A-A
SCALE: 1/8" = 1'-0"

SECTION B-B
SCALE: 1/8" = 1'-0"

TYPICAL WALL PANEL SECTION
SCALE: 1/8" = 1'-0"

NOTE: Details are preliminary and will be modified in final design while retaining the basic scheme.

GRAPHIC SCALE
1/8" = 1'-0" — 4' 0 4' 8' 12' 16' 20'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

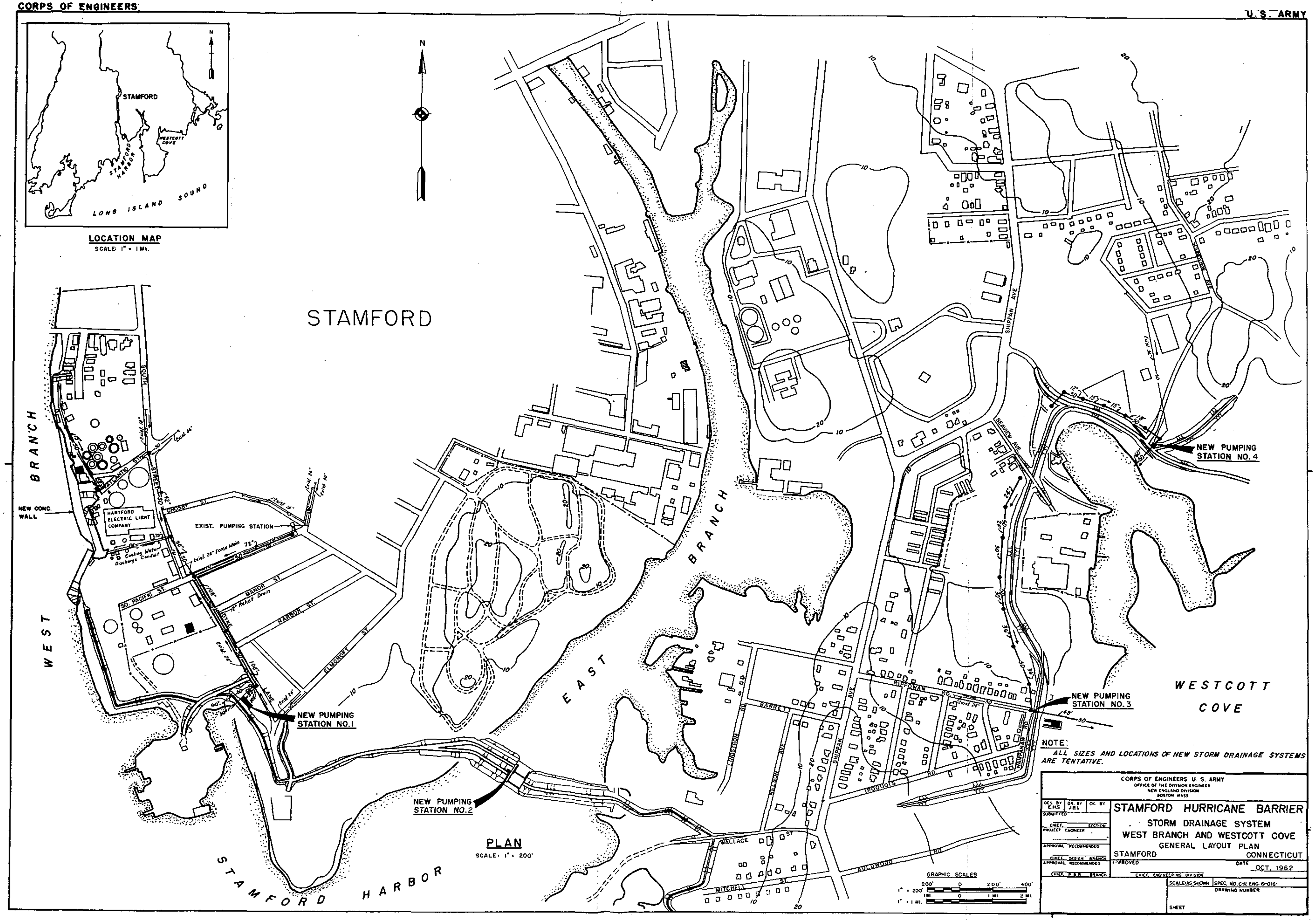
DES. BY A.J.C. | DR. BY D.McD. | CK. BY
SUBMITTED
CHIEF, PROJECT ENGINEER SECTION
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED

STAMFORD HURRICANE BARRIER
PANEL WALL-COAL DOCK AREA
PLAN AND SECTIONS

STAMFORD CONNECTICUT
DATE OCT. 1962

CHIEF, R.E.S. BRANCH
SCALE 1/8" = 1'-0" SPEC. NO. CIV. ENG. 19-CHS-
DRAWING NUMBER
SHEET

PLATE 3-20


LOCATION MAP
SCALE: 1" = 1 MI.
STAMFORD
STAMFORD HARBOR
WESTCOTT COVE
LONG ISLAND SOUND
N
STAMFORD
WEST BRANCH
EAST BRANCH
STAMFORD HARBOR
WESTCOTT COVE
NEW CONC. WALL
HARTFORD ELECTRIC LIGHT COMPANY
EXIST. PUMPING STATION
NEW PUMPING STATION NO. 1
NEW PUMPING STATION NO. 2
NEW PUMPING STATION NO. 3
NEW PUMPING STATION NO. 4
CROSBY ST.
PACIFIC ST.
MANOR ST.
HARBOR ST.
ELMCROFT ST.
SOUTH STREET
ATLANTIC ST.
WAYNE LANE
SHIPPAN AVE.
SEAVIEW AVE.
HIPPOWAN RD.
BARRETT RD.
IROQUOIS RD.
WAMPANAW RD.
LINDSTROM RD.
WALLACE ST.
MITCHELL ST.
RUDDWOOD RD.
PLAN
SCALE: 1" = 200'
GRAPHIC SCALES
1" = 200'
1" = 1 MI.
NOTE:
ALL SIZES AND LOCATIONS OF NEW STORM DRAINAGE SYSTEMS ARE TENTATIVE.
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON MASS
DES. BY E.H.S
DR. BY J.B.L
CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P & R BRANCH
STAMFORD HURRICANE BARRIER
STORM DRAINAGE SYSTEM
WEST BRANCH AND WESTCOTT COVE
GENERAL LAYOUT PLAN
STAMFORD
CONNECTICUT
APPROVED
CHIEF, ENGINEERING DIVISION
DATE OCT. 1962
SCALE: AS SHOWN
SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS

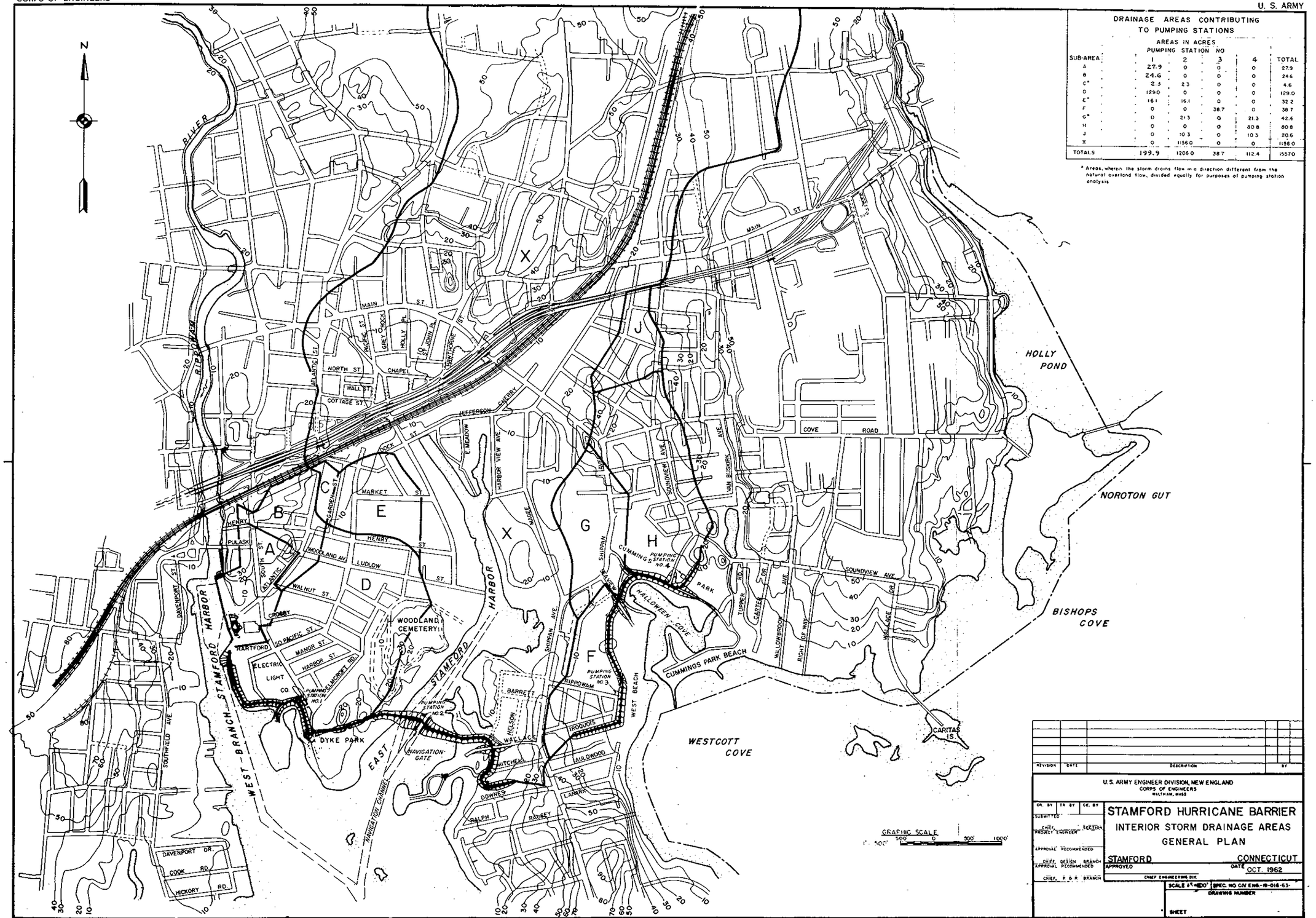
U. S. ARMY

DRAINAGE AREAS CONTRIBUTING TO PUMPING STATIONS

AREAS IN ACRES

SUB-AREA	PUMPING STATION NO 1	2	3	4	TOTAL
A	27.9	0	0	0	27.9
B	24.6	0	0	0	24.6
C*	2.3	2.3	0	0	4.6
D	129.0	0	0	0	129.0
E*	16.1	16.1	0	0	32.2
F	0	0	38.7	0	38.7
G*	0	21.3	0	21.3	42.6
H	0	0	0	80.8	80.8
J	0	10.3	0	10.3	20.6
X	0	1156.0	0	0	1156.0
TOTALS	199.9	1206.0	38.7	112.4	1557.0

* Areas, wherein the storm drains flow in a direction different from the natural overland flow, divided equally for purposes of pumping station analysis.



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DR. BY	TR BY	CK. BY
SUBMITTED		
CHIEF, PROJECT ENGINEER	SECTION	
APPROVAL RECOMMENDED		
CHIEF, DESIGN BRANCH APPROVAL RECOMMENDED		
CHIEF, P & R BRANCH		

STAMFORD HURRICANE BARRIER
INTERIOR STORM DRAINAGE AREAS
GENERAL PLAN

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

CHIEF ENGINEERING DIV.

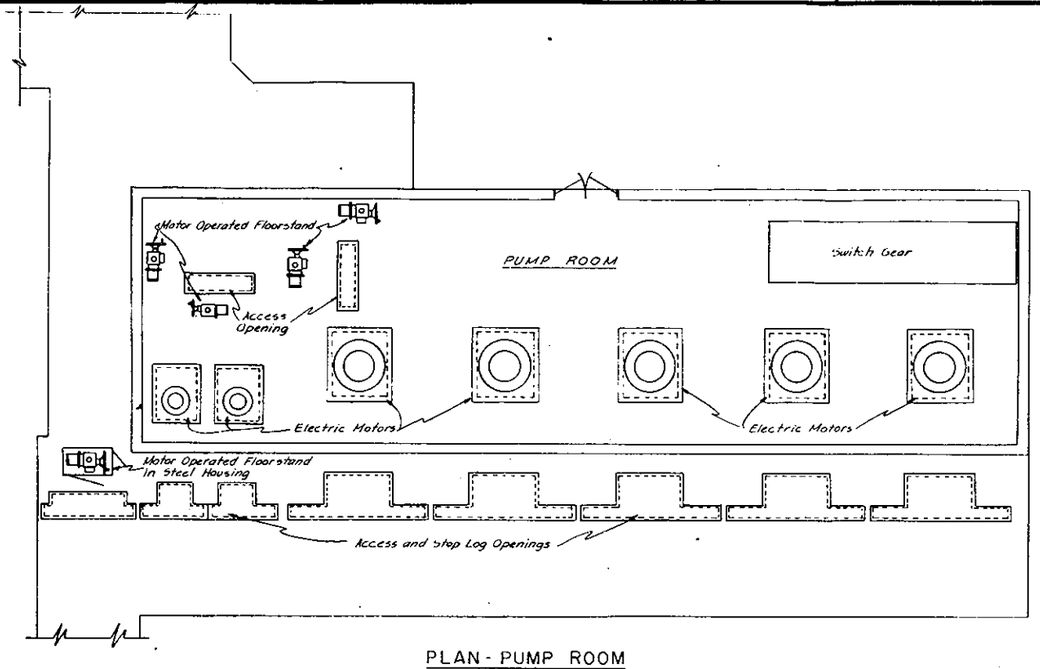
SCALE 1"=400' SPEC. NO CIV ENG-19-016-63-

DRAWING NUMBER

SHEET

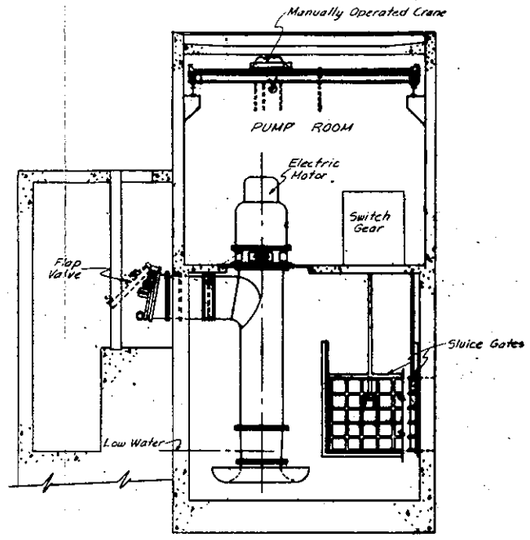
PLATE 3-22

CORPS OF ENGINEERS — U. S. ARMY



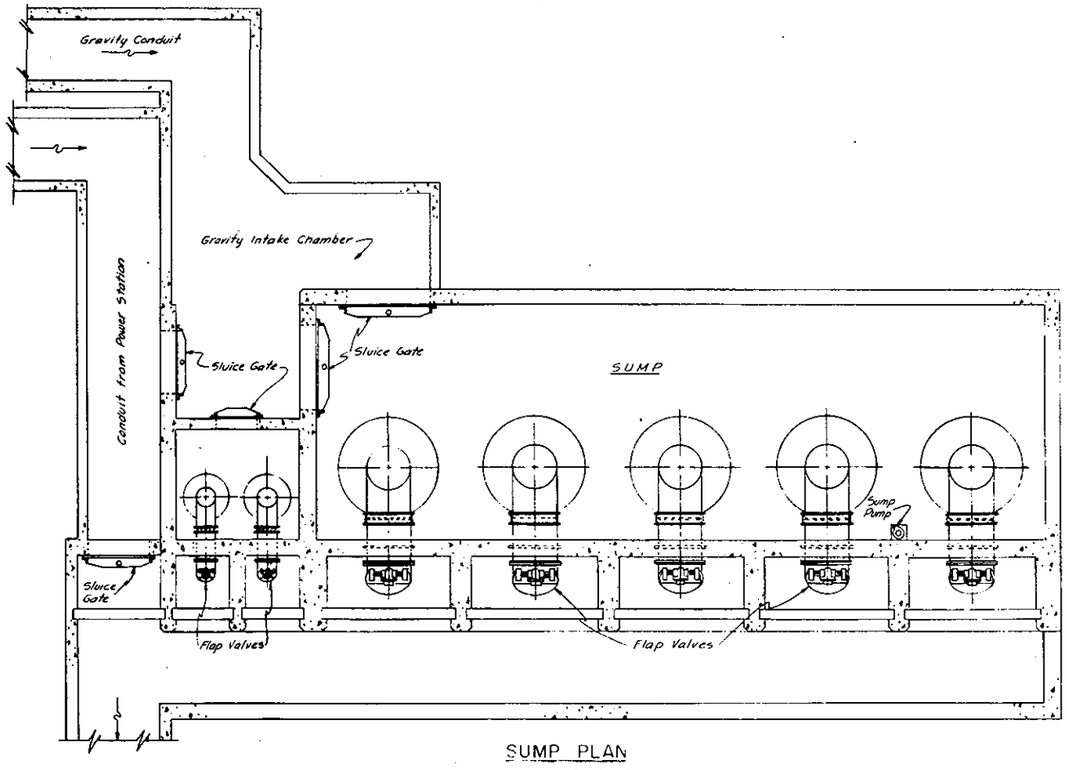
PLAN - PUMP ROOM

SCALE: 3/16"=1'-0"



SECTION AT PUMP

SCALE: 3/16" = 1'-0"



SUMP PLAN

SCALE: 3/16" = 1'-0"

GRAPHIC SCALE

3/16"=1'-0" — 8' 4' 0 8'

NOTES:

Details are preliminary and will be modified in final design while retaining the basic scheme.
Gravity conduits may be combined or separate as indicated, as determined in final design.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.W.F. | DR. BY R.P.C. | CK. BY

SUBMITTED — CHIEF, SECTION

PROJECT ENGINEER

APPROVAL RECOMMENDED — CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED — CHIEF, ENGINEERING DIVISION

STAMFORD HURRICANE BARRIER
PUMPING STATION NO. 1
PLANS AND SECTION

STAMFORD — CONNECTICUT

APPROVED — DATE OCT 1962 — CHIEF, OPERATIONS DIVISION

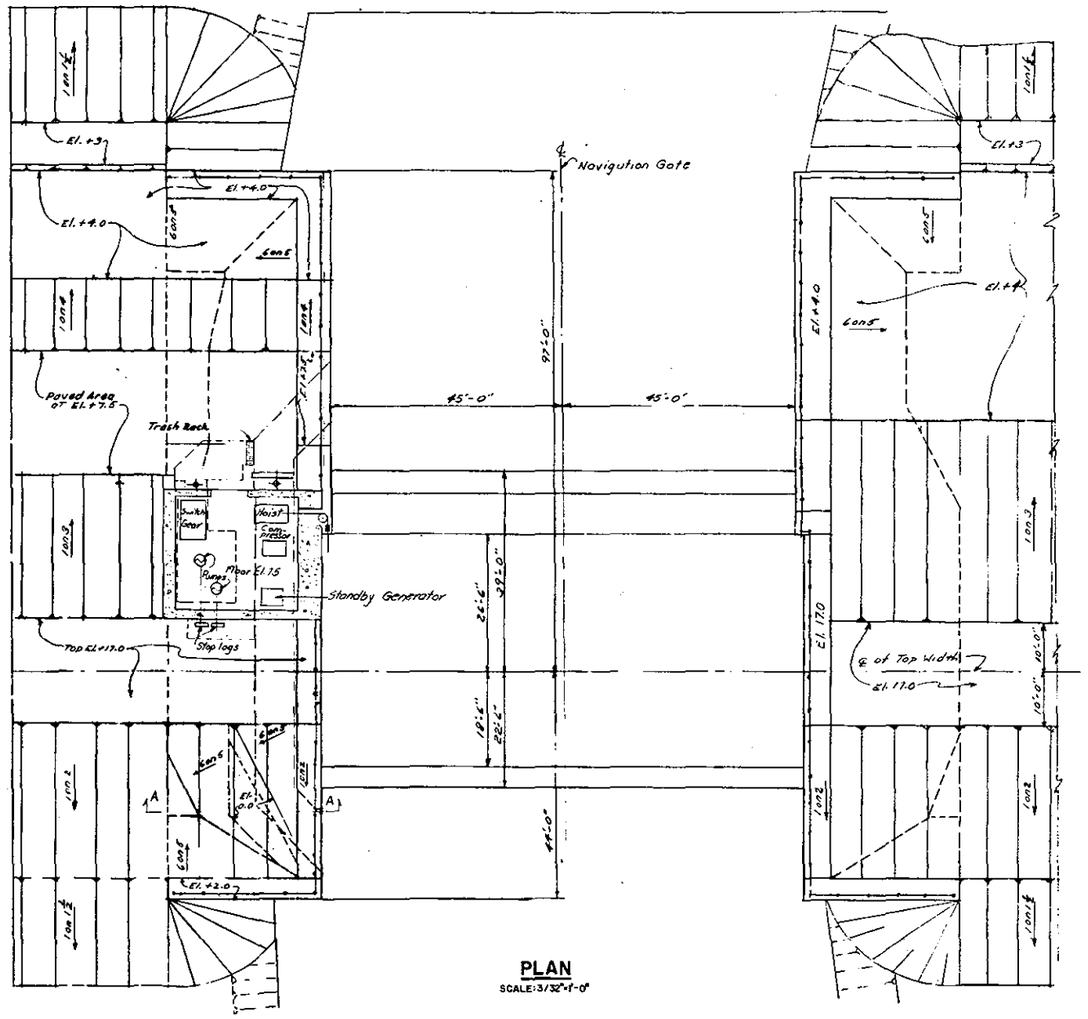
SCALE 3/16"=1'-0" | SPEC. NO.

DRAWING NUMBER

SHEET

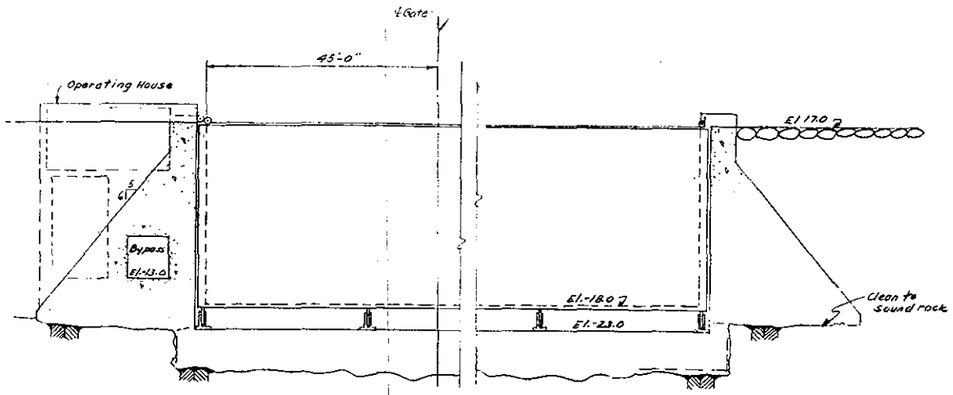
PLATE 3-23

CORPS OF ENGINEERS — U. S. ARMY



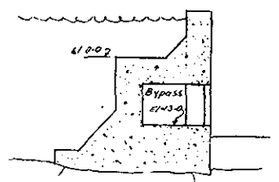
PLAN

SCALE: 3/32"=1'-0"



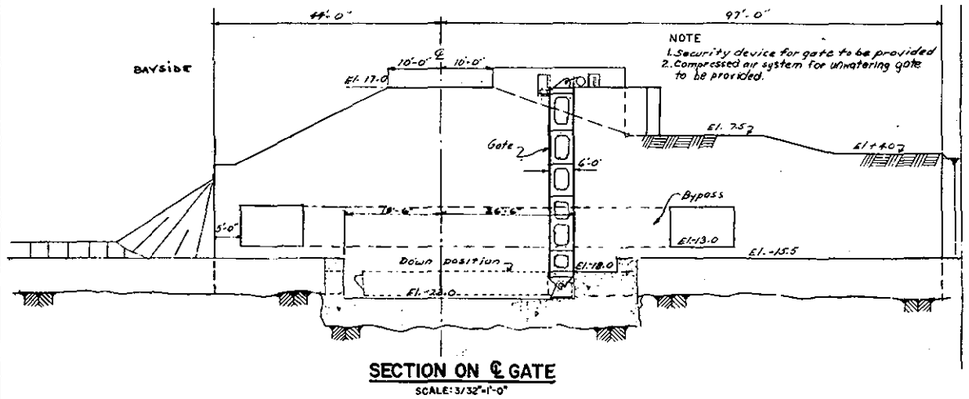
SECTION ON ℄ BARRIER

SCALE: 3/32"=1'-0"



SECTION "A-A"

SCALE: 3/32"=1'-0"



SECTION ON ℄ GATE

SCALE: 3/32"=1'-0"

NOTE:
General Layout is indicated, dimensions and details are preliminary.

GRAPHIC SCALE

3/32"=1'-0" 11' 0 11' 21'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF, ENGINEERING SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, MILITARY BRANCH

STAMFORD HURRICANE BARRIER
NAVIGATION GATE-EAST BRANCH
PLAN AND SECTIONS

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

CHIEF, ENGINEERING DIVISION

SCALE: 3/32"=1'-0" SPEC. NO. CIV. ENG. 19-016-63-

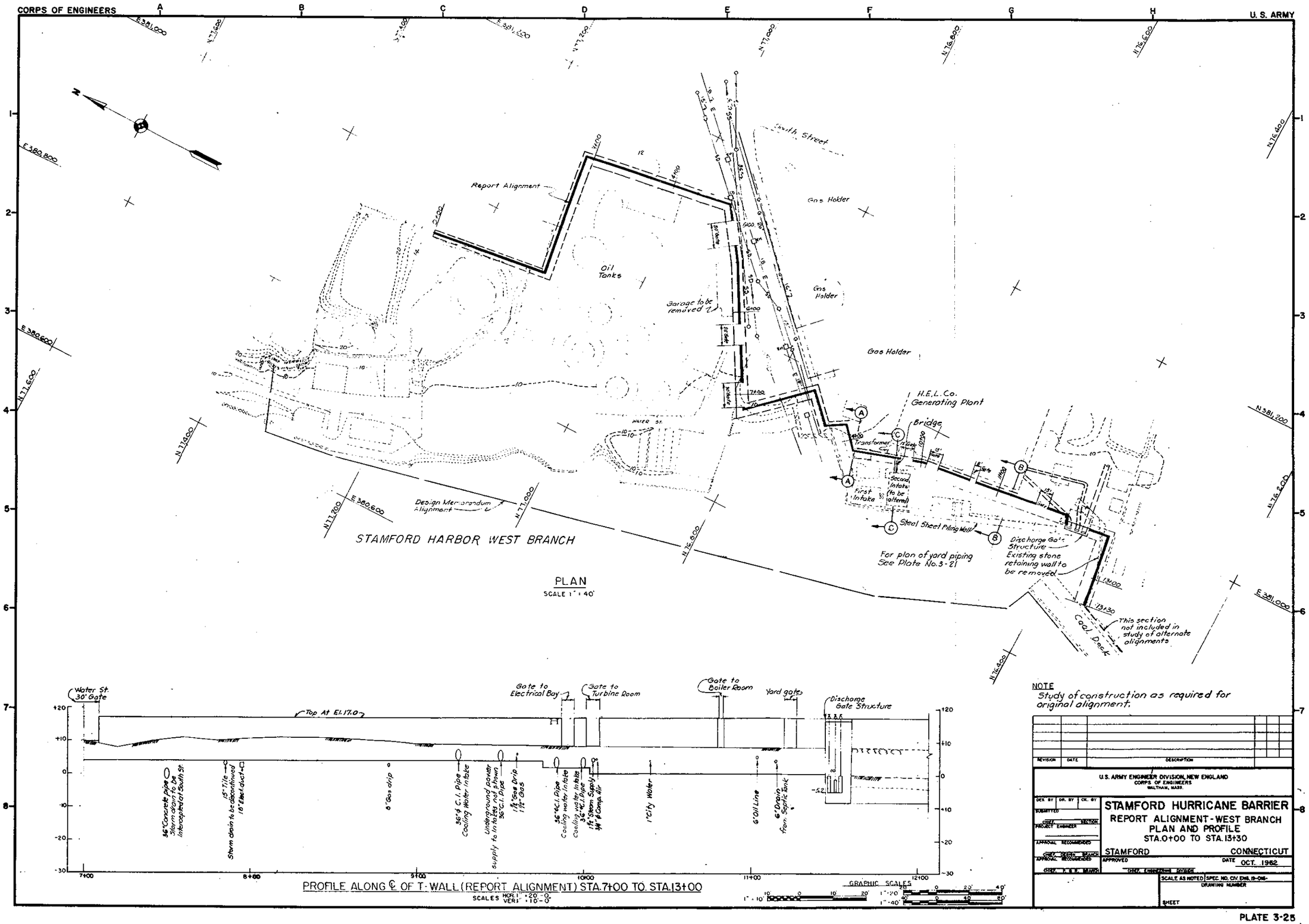
DRAWING NUMBER

SHEET

PLATE 3-24

CORPS OF ENGINEERS

U. S. ARMY



PLAN
SCALE 1" = 40'

PROFILE ALONG ℄ OF T-WALL (REPORT ALIGNMENT) STA. 7+00 TO STA. 13+00
SCALES HOR. 1" = 20'-0"
VERT. 1" = 10'-0"

GRAPHIC SCALES
1" = 10'
1" = 20'
1" = 40'

NOTE
Study of construction as required for original alignment.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY

SUBMITTED
CHIEF, ENGINEERING SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, E & D BRANCH

STAMFORD HURRICANE BARRIER
REPORT ALIGNMENT - WEST BRANCH
PLAN AND PROFILE
STA. 0+00 TO STA. 13+30

STAMFORD CONNECTICUT

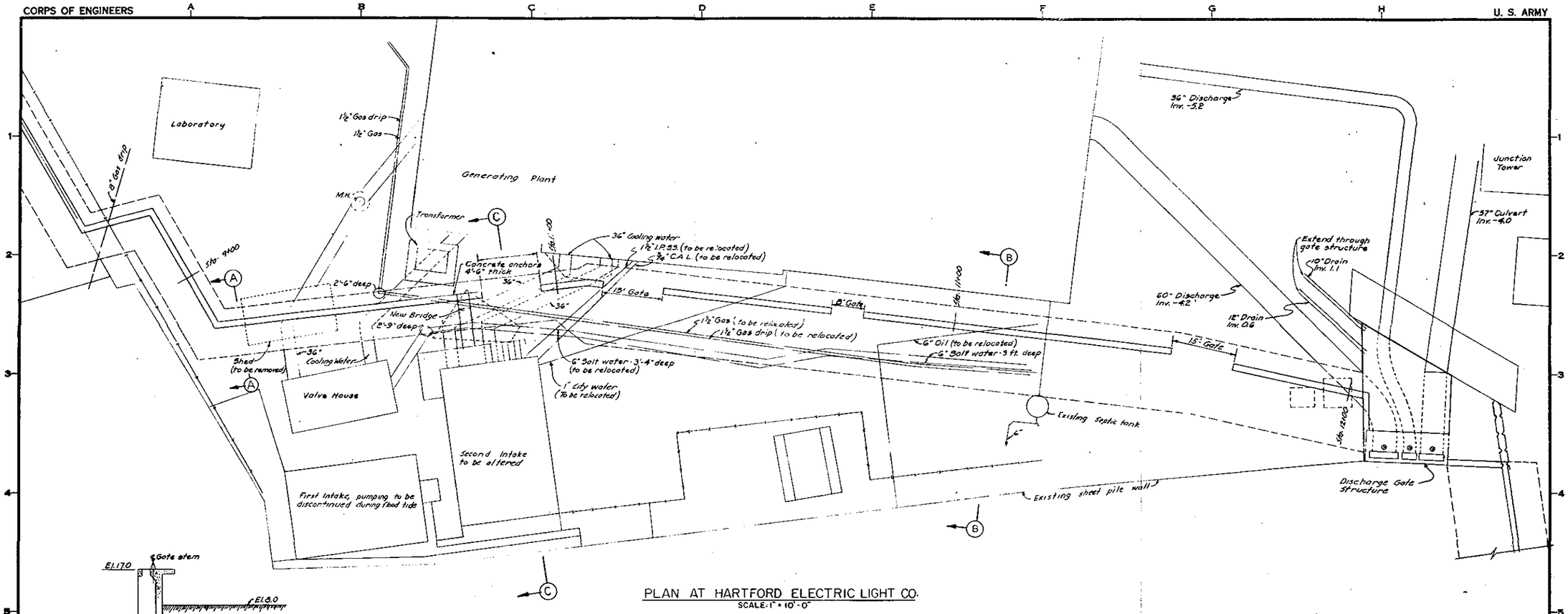
APPROVED DATE OCT. 1962
CHIEF, ENGINEERING DIVISION

SCALE AS NOTED | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

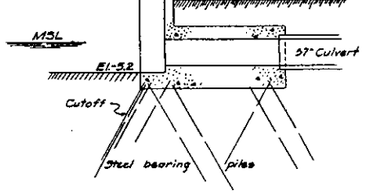
PLATE 3-25

CORPS OF ENGINEERS

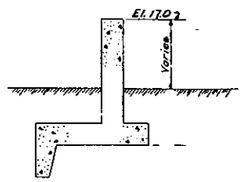
U. S. ARMY



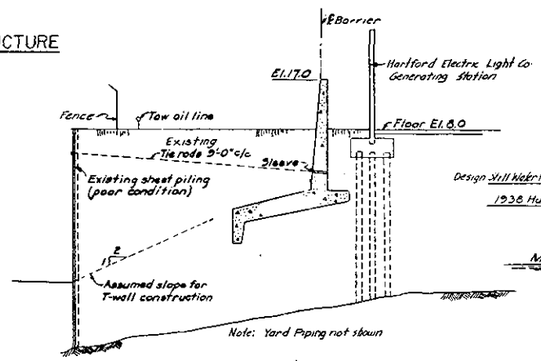
PLAN AT HARTFORD ELECTRIC LIGHT CO.
SCALE: 1" = 10'-0"



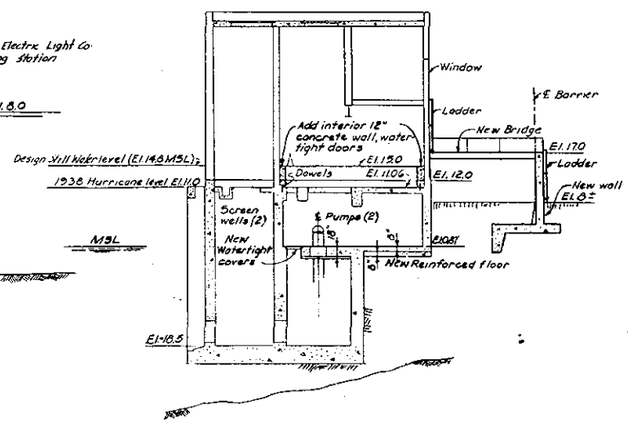
SECTION THROUGH GATE STRUCTURE



SECTION A-A
SCALE: 1/4" = 1'-0"



SECTION B-B
SCALE 1" = 10'-0"



SECTION C-C AT SECOND INTAKE
SCALE: 1" = 10'-0"

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY J.C.L. C.M.O. | CK. BY

SUBMITTED

CHIEF, PROJECT ENGINEER SECTION

APPROVAL RECOMMENDED

CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED

CHIEF, E & D BRANCH

STAMFORD HURRICANE BARRIER

REPORT ALIGNMENT-WEST BRANCH PLAN AND SECTIONS STA. 9+00 TO STA. 12+00

STAMFORD CONNECTICUT

APPROVED

DATE OCT. 1962

CHIEF, ENGINEERING DIVISION

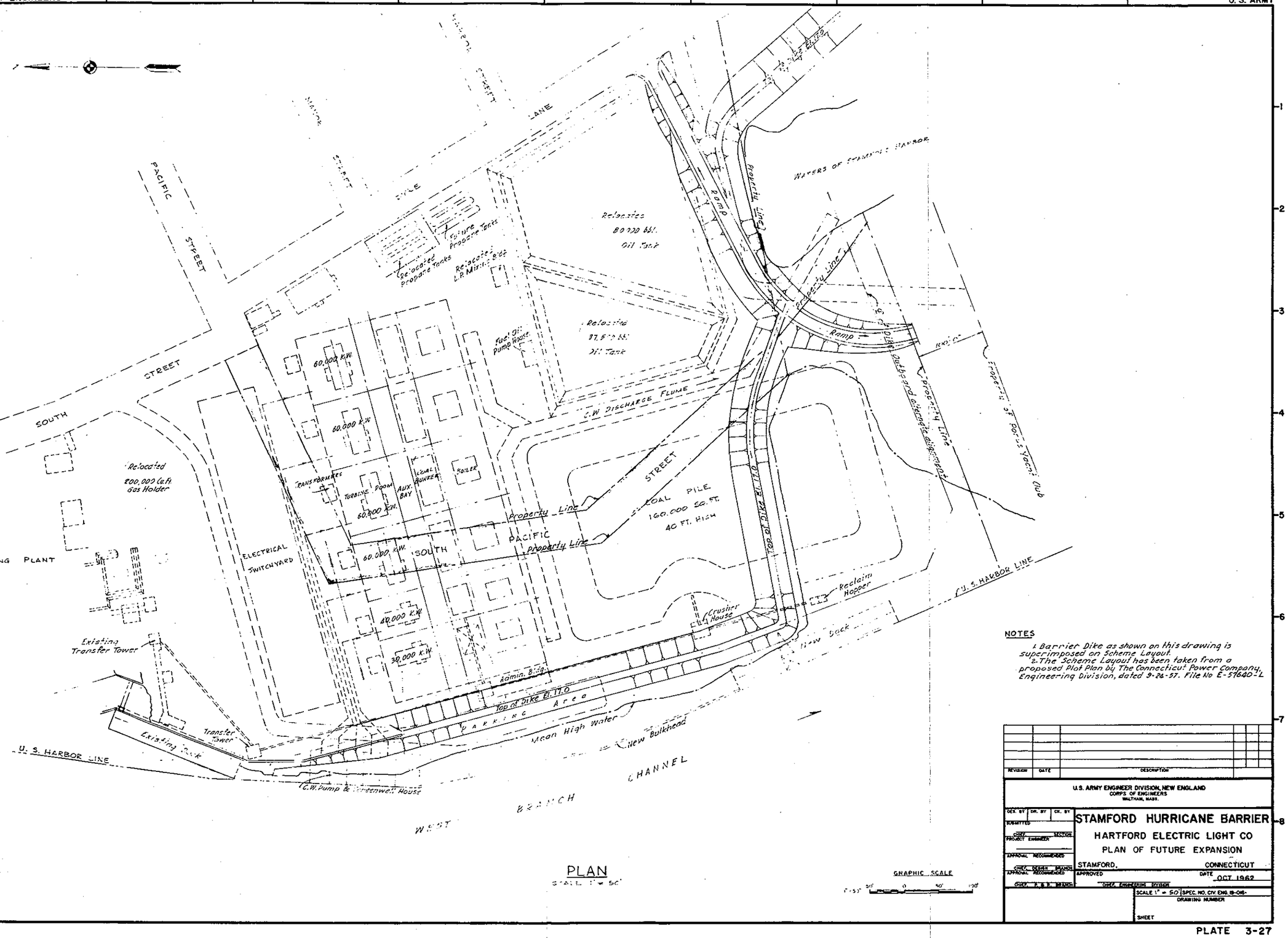
SCALE AS NOTED | SPEC. NO. CIV. ENG. 19-ONE-

DRAWING NUMBER

SHEET

PLATE 3-26

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE 1" = 50'

GRAPHIC SCALE
FEET 50' 0 50' 100'

NOTES

1. Barrier Dike as shown on this drawing is superimposed on Scheme Layout.
2. The Scheme Layout has been taken from a proposed Plot Plan by The Connecticut Power Company, Engineering Division, dated 9-24-57. File No E-57640-L

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF R. & D. BRANCH

STAMFORD HURRICANE BARRIER
HARTFORD ELECTRIC LIGHT CO
PLAN OF FUTURE EXPANSION
STAMFORD, CONNECTICUT

APPROVED
DATE OCT 1962
CHIEF ENGINEERING DIVISION

SCALE 1" = 50' | SPEC. NO. CIV. ENG. 18-018-
DRAWING NUMBER
SHEET

PLATE 3-27

APPROPRIATION TITLE: Construction, General
CLASSIFICATION: LOCAL PROTECTION PROJECT

PROJECT: STAMFORD HURRICANE BARRIER, STAMFORD, CONNECTICUT

ACTIVITY LEGEND
Advertising — No Earnings
Planning — Contract Award — Earnings

DETAILED PROJECT SCHEDULE (PB-2a)

(TO BE REPORTED IN THOUSANDS OF DOLLARS)

LINE NO.	COST ACCOUNT NO.	ITEM	CONT. TYPE & NO.	QUANTITY, SIZE, OR CAPACITY; DATE OF AWARD (As Applicable)	PROJECT COST ESTIMATE	TOTAL AS OF JUNE 30, 19 62	CURRENT FISCAL YEAR 19 63 TOTAL	CURRENT FISCAL YEAR 19 63 QUARTERS 1st	2nd	3rd	4th	BUDGET FISCAL YEAR 19 64 TOTAL	BUDGET FISCAL YEAR 19 64 QUARTERS 1st	2nd	3rd	4th	FUTURE FISCAL YEARS 19 65 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	19 66 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	19 ____ 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	19 ____ 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	19 ____ 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	BALANCE TO COMPLETE	LINE NO.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)				(18)				(19)				(20)				(21)				(22)	
1	01.	LANDS AND DAMAGES			500.0							500.0	100.0	400.0																				1
2																																		2
3	02.	RELOCATIONS (A2-1)	C.C.		113.0							20.0				20.0	76.0			17.0														3
4																																		4
5	.2	PARKING AREAS	C.C.		(36.0)							(10.0)				(10.0)	(26.0)																	5
6																																		6
7	.3	UTILITIES	C.C.		(77.0)							(10.0)				(10.0)	(50.0)			(17.0)														7
8																																		8
9	11.	LEVEES AND FLOODWALLS (A2-2)	C.C.		3,875.0							140.0				140.0	2,560.0			1,175.0														9
10																																		10
11	.1	LEVEES AND FLOODWALLS	C.C.		(2,672.0)							(140.0)				(140.0)	(1,610.0)			(922.0)														11
12																																		12
13	.2	NAVIGATION GATE	C.C.		(1,203.0)												(950.0)			(253.0)														13
14																																		14
15	13.	PUMPING PLANTS (A2-3)	C.C.		1,162.0							50.0				50.0	946.0			166.0														15
16																																		16
17	29.	PREAUTHORIZATION STUDIES			50.0	50.0																												17
18																																		18
19	30.	ENGINEERING AND DESIGN			437.0	90.0	230.0					70.0	52.0	6.0	6.0	6.0	33.0			14.0														19
20																																		20
21	31.	SUPERVISION AND ADMINISTRATION			445.0	7.0	23.0					20.0	4.0	1.0	4.0	11.0	285.0			110.0														21
22																																		22
23		TOTAL APPLIED COST (Federal Funds & Non-Federal Contributions)			6,582.0	147.0	253.0					800.0	156.0	407.0	10.0	227.0	3,900.0			1,482.0														23
24		Undistributed Cost (None)																																24
25		TOTAL PROJECT COST (Federal Funds & Non-Federal Contributions)			6,582.0	147.0	253.0					800.0	156.0	407.0	10.0	227.0	3,900.0			1,482.0														25
26		NON-PROJECT COST			270.0							40.0	40.0				230.0																	26
27		Pending Adjustments (None)																																27
28		TOTAL COST (Federal Funds & Non-Fed. Contributions)			6,852.0	147.0	253.0					840.0	196.0	407.0	10.0	227.0	4,130.0			1,482.0														28
29																																		29
30		FEDERAL FUNDS																																30
31		TOTAL COST			4,069.0	147.0	253.0					300.0					2,800.0			569.0														31
32		NON-FEDERAL FUNDS																																32
33		TOTAL COST			2,783.0							540.0					1,330.0			913.0														33
34		Undelivered Orders (None)																																34
35		TOTAL OBLIGATIONS (Federal and Non-Federal Contributions)					253.0					840.0					4,130.0			1,482.0														35
36																																		36
37		METHOD OF FINANCING																																37
38		FEDERAL FUNDS																																38
39		APPROPRIATIONS				150.0	250.0					300.0					2,800.0			569.0														39
40		UNOBLIGATED CARRYOVER FROM PRIOR YEAR					3.0																											40
41		TOTAL FUNDS AVAILABLE FOR OBLIGATION					253.0																											41
42		APPROPRIATION REQUIRED										300.0					2,800.0			569.0														42

EFFECTIVE DATE: 15 October 1962
DIVISION: NEW ENGLAND
DISTRICT:
BASIN: NEW ENGLAND

ENG FORM 1 MAY 58 2201a (Translucent) EDITION OF 1 DEC. 58 MAY BE USED UNTIL EXHAUSTED (ER 11-2-101)

PLATE 3-28